BELL LABORATORIES RECORD

JUNE 1951 • VOLUME XXIX • NUMBER 6

THE COVER: Holding a condenser microphone, E. W. Conger checks the output of an artificial mouth used in the Laboratories to test the response of telephone transmitters. See page 255.

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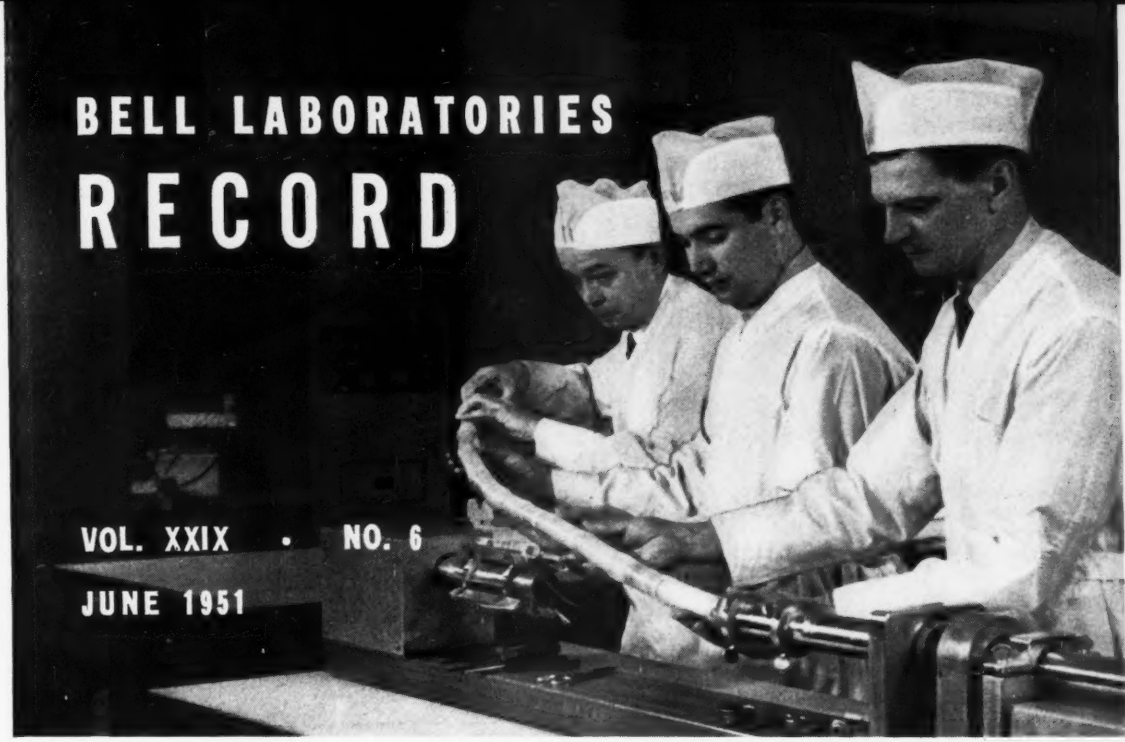

E. M. BOARDMAN
Transmission Development

Assembling the submarine cable amplifier

Building the repeaters* for the Key West-Havana submarine cable† with the objective of a long, trouble-free life required meticulous attention to a number of problems. The efforts of several Laboratories' groups were concentrated on a myriad of details of design, development, and construction, to produce amplifiers capable of giving the desired characteristics.

To permit laying the repeater along with the cable, it was necessary that its parts be mounted in a flexible tubular container that would pass over the brake drum and sheaves in the same way as the cable. The amplifier is divided into spring coupled sections, each section being limited in length to 4¼ inches and having a diameter of 1½ inches. Of this diameter, the useful portion for mounting circuit elements is 1-3/16 inches. Although no maximum over-all length of the repeater was critical, wiring effects, handling, shipping and laying made it desirable to keep the total length short. Fifteen sections resulted in an amplifier six feet long.

A schematic of a complete amplifier is shown in Figure 4. Two end sections contain terminals for connecting to the central cable conductor and to ground. One section contains a desiccator for final drying of the entire container. In the remaining 12 sections are a total of 58 electrical elements. Three sections have the three electron tubes, and three other sections contain high voltage capacitors only. A seventh section contains a quartz crystal and resistor, leaving five sections with a combined volume less than that of a 3-inch cube to hold the remaining 50 elements. Squeezing these elements into the small space available was partly accomplished by combining certain elements—using the unproductive center of a cylindrical capacitor as a housing for a resistor,

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The illustration at the top of the page shows E. M. Boardman, W. P. Cucco and J. D. Cuyler removing an assembled amplifier from the assembly fixture.

* For the purposes of this article, the repeater is defined as an amplifier housed in a water-tight container with all the needed seals, bedding and protective armor required to permit laying in deep water.

† RECORD, *April*, 1951, *page* 149.

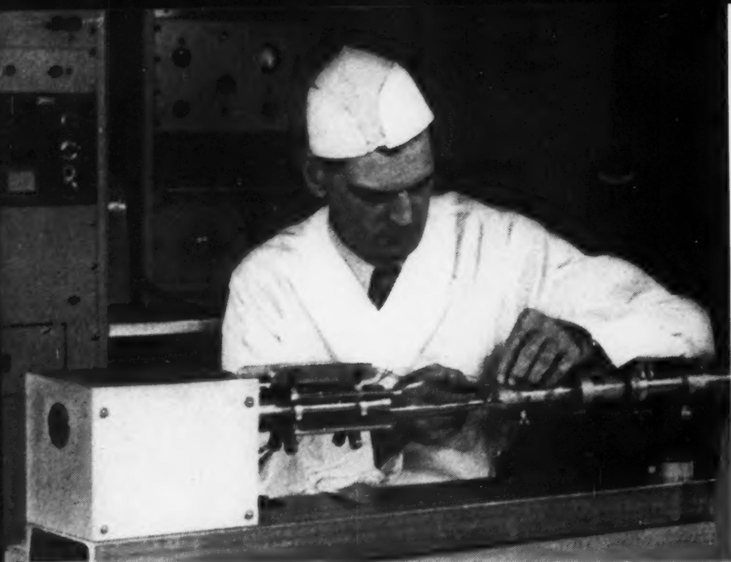


Fig. 1—(above left)—J. D. Cuyler assembling the sections of the submarine cable amplifier, using the special fixture designed for the purpose.

Fig. 2—(above)—The electron tube section, an input network, and samples of components.

Fig. 3—(left)—Connections between each section of the amplifier were made by 8 longitudinal tapes. In this picture, a section is ready for the cover to be slipped on.

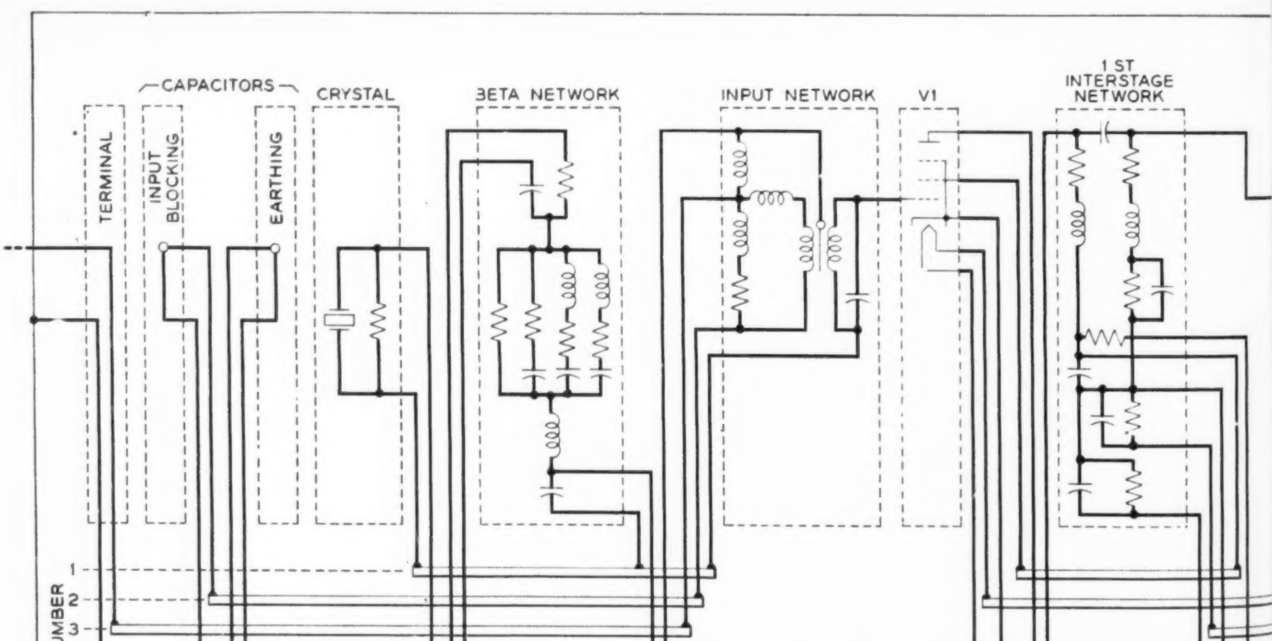


Fig. 4—Schematic of a complete amplifier. Bus tapes are numbered

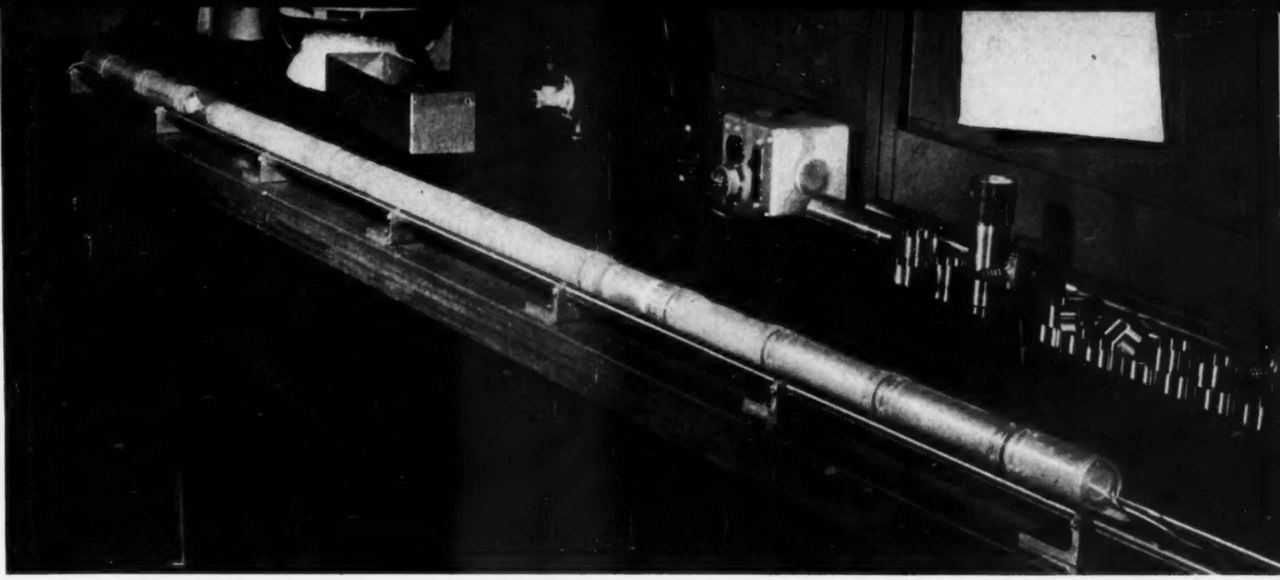
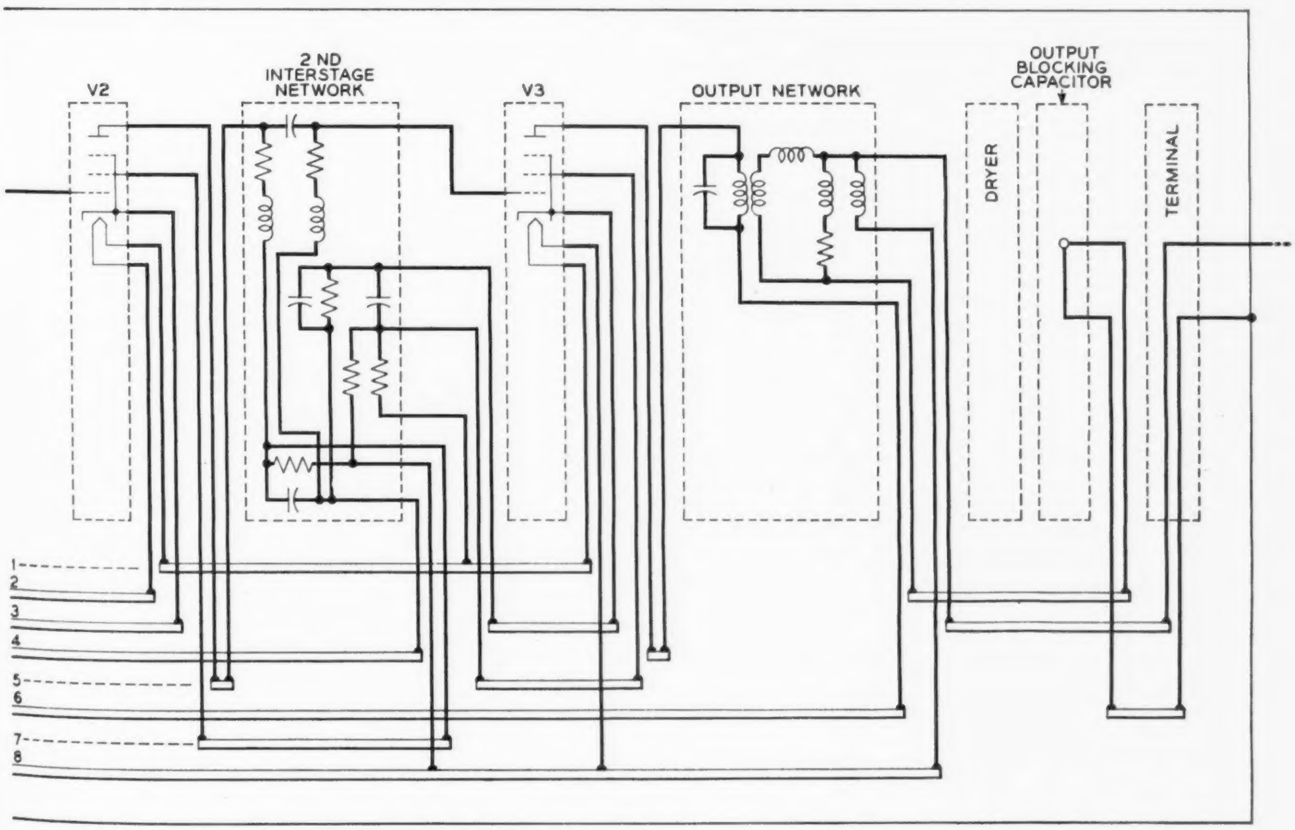


Fig. 5—A complete amplifier is ready to be enclosed in the series of steel rings shown in the background.

adding resistance windings to coils, and by using multiple capacitor structures – and partly by careful packaging. As many as 13 circuit elements were mounted in a section.

Complex mounting forms were required in assembling these elements into the several networks. These were made of methyl-methacrylate (Lucite or Plexiglas) machined to shape. The great bulk of this machining was done in the Development Shops of the Laboratories, where the required high degree of mechanical skill was available.

During the earlier development, particularly on high-voltage capacitors, the need for controlled atmospheric conditions and extreme cleanliness became obvious. Consequently, the entire construction of the repeater, up to hermetic sealing of the whole container, was done in an area of six inter-



clockwise when facing into container at out-put end.

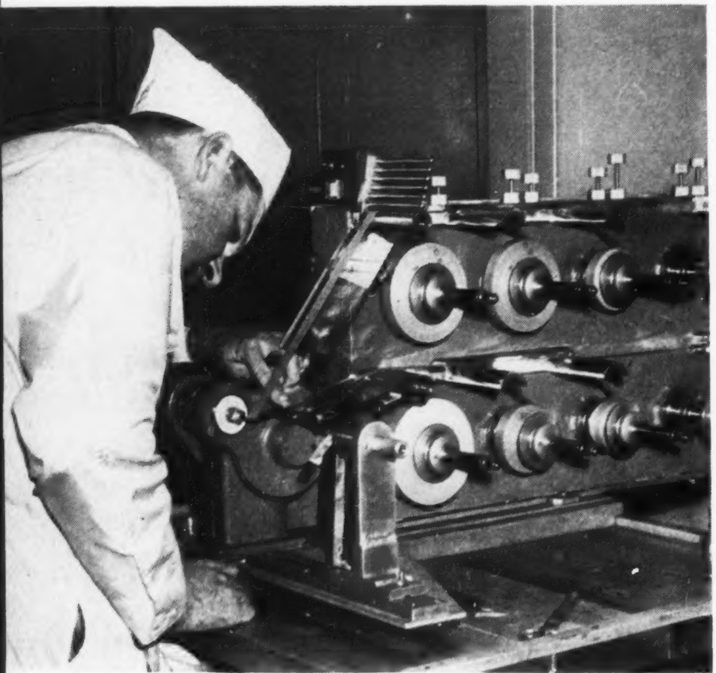


Fig. 6–M. L. Wald winds foil and paper capacitors for the amplifier in an air-conditioned room.

connected air-conditioned rooms at the Murray Hill Laboratory. A separate room in this area was used for paper capacitor winding, the relative humidity being kept lower than that in the other rooms. In all rooms, multiple filtering of the air was provided. Persons working in the area were required to change their outer clothing, including shoes, and to wear special clothing provided by the Laboratories. Smoking and the bringing in of food was prohibited. Visitors were purposely kept few, and these were required to wear special smocks.

With development and building of parts proceeding side-by-side, usual methods of manufacture could not be employed. Circuit elements, networks and amplifiers were built by Development Shop personnel and all of this work was subject to constant engineering inspection. Complete networks were given impedance and transmission measurements on specially developed testing equipment; examples of these networks are shown in Figure 2. One of each type of section was carried through a series of vibration and shock tests to prove it capable of withstanding the mechanical abuse incident to the handling, shipping, and laying of the repeatered cable.

As the sections became available, they were assembled into the amplifier in a special fixture (Figure 3). Every splice, part, and operation was inspected before being covered by further work, and each type of network was as nearly like its counterpart, in positioning of elements and wiring, as close tolerances, machining, and assembly could make it. Wiring between sections was accomplished by using as many as required of eight longitudinal tapes spaced around the periphery of the cylindrical sections, as indicated in Figure 1. These tapes were anchored once in each section to prevent creep, had slack between sections to permit bending, and were soldered to circuit ele-

THE AUTHOR: During his college career, E. M. Boardman spent two periods at the Bell Laboratories. In the summer of 1926, while attending Iowa University, he worked on a high-speed submarine telegraph cable; in 1927 he was in the measurements group, now headed by S. J. Zammataro. In the following two years, Mr. Boardman was research assistant to Dr. L. W. McKeehan, formerly of the Bell Laboratories, who at that time became professor of Physics and Director of Sloane Laboratory at Yale University. In 1929, Mr. Boardman returned to the Laboratories, where he again became engaged in submarine cable development. As a part of this work, he spent a year and a half in Ireland measuring audiofrequency atmospherics. Following this he was concerned with magnetic amplifier development, acoustic measurements, and coil design, returning to cable work in 1941. His activities on the Key West - Havana cable involved the mechanical design of the amplifiers. Subsequent to the laying of the cable, he transferred to a group in the Transmission Apparatus Development Department where he has since been engaged in packaging problems involving printed circuits and plastic encasement.

ments and networks at the section ends as shown in Figure 3.

Transmission measuring equipment capable of 0.005 db sensitivity was used in adjusting transformer ratios, groups of interdependent elements forming portions of networks, and for completion tests on networks and amplifiers. Impedance measurements were made on certain network branches for which the transmission measurement did not provide a sufficient check. The feedback loop characteristic was determined from measurements of the impedance between the plate and cathode of the output electron tube with the amplifier energized and not energized. This characteristic provides an indication of the gain stability of the amplifier and its margin against singing.

The amplifier was then enclosed under a steel ring cover that furnishes the strength and flexibility required, and the end seals were put in place and electrically connected to the amplifier leads. The entire assembly was then slipped into a copper tube which, with the seals, provided the moisture barrier.

Fig. 7—R. P. Wells is shown operating the network test equipment.

It is not possible to name all the many persons who contributed to the development and construction of these amplifiers. The many groups within the Laboratories whose interests bore directly and indirectly on this project were called upon for assistance in many ways; the Development Shops contributed their skills and suggestions, the Chemical and Materials Groups prepared and tested materials, as well as suggested what to use in many cases, and the Service Groups obtained items needed for use in the project. Advantage was taken of the technical knowledge and experience of departments throughout the entire Bell Telephone Laboratories.

Acknowledgments

Of the many persons who contributed to the development and manufacture of the amplifiers, it is only natural that certain names will stand out. Early designs were built under the direction of W. M. Bishop and W. Gronros in the 1930's and given trials in shallow water off the coast of New Jersey. A twelve-channel design by O. B. Jacobs, D. E. Thomas and I. E. Wood was built and tested in deep water off the Bahamas. Laboratory models were built by H. Alfke.

Circuits for the final twenty-four-channel design were developed under the direction of L. M. Ilgenfritz. Electron tubes were built under the direction of J. O. McNally, and quartz crystals were furnished by W. J. Carroll; other circuit components were built in the special laboratory at Murray Hill under the direction of A. H. Schafer, B. Slade, and M. C. Wooley. Completed networks were measured by R. Wells and assembly of the sections was done by J. D. Cuyler. The design drafting was done by G. W. Carlson.

D. E. Thomas planned the electrical circuit design for the transmission measuring equipment, and the equipment design, laboratory testing, and installation were by G. W. Cowley and D. M. Osterholz. Construction of the component parts was done by Development Shop personnel under M. T. Slacum. Mr. Jacobs had over-all charge of the Murray Hill component and amplifier laboratory.

Lepeth cable splicing

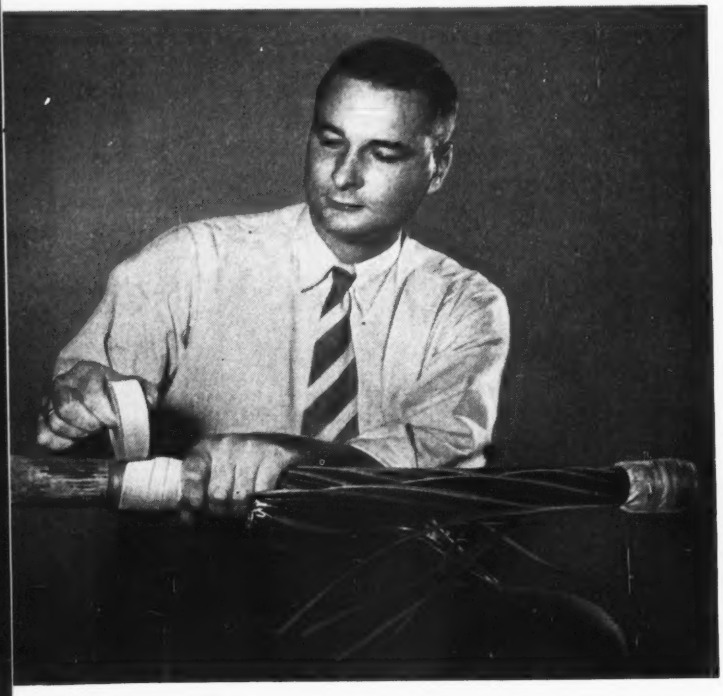
D. T. SHARPE
Outside Plant Development

"Lepeth" is the coined name given to a telephone cable sheath that is a composite of lead and polyethylene.* A layer of polyethylene 0.075 inch thick is extruded over the cable core, followed by an extruded lead sheath 0.100 inch thick. To prevent longitudinal flow of gas or water along the interspace, a rubber and asphalt cement is applied between the polyethylene and lead. Where mechanical protection is desired, a modified tape armor is applied over the lead; a jute covering is provided where only corrosion protection is necessary.

Composite sheathing of this type is widely used for buried toll cables. This is because the high dielectric strength of the polyethylene between the core and outer sheath enables the cable to withstand severe lightning storms, and because the double sheath barrier has greater reliability against water penetration. The mechanical support introduced by the polyethylene permits the use of a thinner lead sheath than would be possible if lead were used alone.

* RECORD, *June*, 1950, *page* 241.

Fig. 1—Additional dielectric strength is furnished by winding rubber tape over the ends of the polyethylene and core covers. J. M. Jackson is applying the tape wrapping.



Splicing of the Lepeth cable during installation introduced a problem in that the splice must be at least the equivalent of the cable in dielectric strength. The polyethylene jacket provides a dielectric strength of 20,000 volts d-c or more between the cable conductors and the lead sheath, which, as a result of field observations by Laboratories engineers, is considered to be sufficient to prevent damage to the cable structure. Since the polyethylene inner sheath forms the barrier against conductor damage from lightning discharges traveling along the lead sheath, it is essential that the core be insulated from the lead sheath at splice points as well as throughout the length of the cable.

Several wrappings of 0.008 inch polyethylene tape around the bundle of spliced conductors provide a satisfactory covering over the greater part of the splice; the problem, however, lies at the end of the sheath where the lead and polyethylene are terminated. When the lead sleeve is applied to a cable splice, the solder wiping operation employed to seal the sleeve to the lead sheath raises the temperature of the underlying polyethylene to a value well above its melting point. Since this material becomes a fluid at temperatures above 200 degrees F, there is a possibility that holes, thin spots, or escape of some of the melted polyethylene may occur, with consequent reduction in dielectric strength. Laboratory tests have shown that such damage can be prevented by supporting the lead sleeve and lead end plates so that this weight does not bear against the lead sheath during the wiping operation. A device for supporting the sleeve, as shown

in Figure 2, was developed for field use. It consists of a simple frame suspended from the cable at each side of the splice point. At the center of the frame is an adjustable support for the lead sleeve; thus, the weight of the sleeve is transferred from a point where the polyethylene is softened by the solder wiping operation to a point well away from this area.

In addition to preserving the physical shape and condition of the polyethylene sheath at the end sections of a splice, it is also necessary to provide a dielectric barrier between the end of the lead sheath and the core. This is accomplished by terminating the polyethylene 1 inch beyond the lead and applying a rubber tape over the polyethylene and lead as shown in Figure 1. Tests have shown that dielectric strength without the supplementary tape cannot consistently be depended upon to give the desired equivalent dielectric properties of the cable.

Heat from the wiping operation causes the cement in the interspace to become fluid and expand. This fluid cement tends to flow back through the molten solder while the joint is being wiped. Such leakage is apt to cause porosities in the cooled joint which are difficult to seal. The rubber tape seal at the end of the lead sheath, supplemented by several tightly applied turns of ⅛ inch rubber cord, prevents escape of the fluid cement.

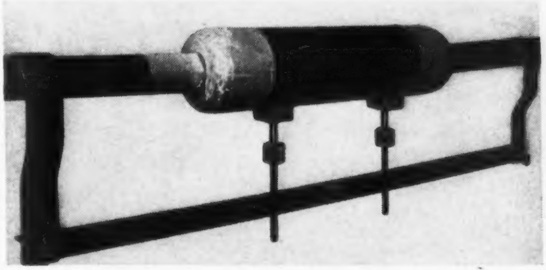
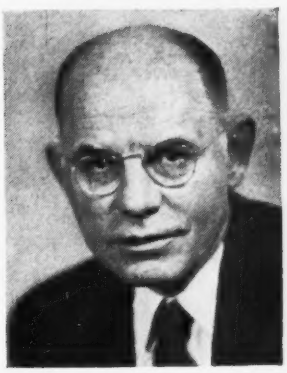


Fig. 2—When the splice is made, the weight of the lead sleeve is supported at a distance from the splice itself.

Laboratory tests have shown this splice to be at least equal in dielectric strength to the cable itself. The capability of the splice has been further confirmed by the fact that, during the several years that Lepeth cable has been in service, particularly in heavy lightning areas, no difficulty with breakdown of the cable splice has been experienced.

THE AUTHOR: After two years at Iowa State College, D. T. SHARPE entered the U. S. Steel Corporation, Engineering Department, in 1924. Here he was concerned principally with fuel economy studies, but also took a two-year metallurgical course. Coming to the Laboratories in 1928, he became a member of Outside Plant Development, becoming concerned with problems relating to cable splicing and maintenance. Since World War II, he has been active in splicing studies in connection with the development of new types of cable sheaths and on improvements in gas pressure testing methods.



Automatic calibration of film scales for oscillators

T. SLONCZEWSKI
Transmission Measurements

As the frequency range of an oscillator is increased, the control dial must be made larger to accommodate the longer scale. An oscillator[1] developed some years ago was continuously variable from 1 to 100 kc, and if a dial had been used, it would have had to be 5 feet in diameter to secure the desired precision of reading. To avoid this impractical situation, the dial controlling the worm driven tuning condenser was also geared to a pair of film sprockets that carried nearly 20 feet of 35-mm film on which the frequency scale was printed. Although this film scale greatly simplified the reading of the oscillator frequency, a large amount of time and labor were required to calibrate such a long scale. This calibration was done in two steps. Points 1 kc apart were first individually marked on the film by calibration against a standard frequency. The space between these calibrated points was then divided into ten equal parts by hand. This dividing process was slow and tedious, and required considerable time. It was subsequently reduced, first by designing pencil-guiding tools that permitted the equal spaces to be more easily determined and marked, and later by a printing process[2]. For the 17-B oscillator[3], a film 25 feet long was required to cover the frequency range from 1 to 150 kc, and between the calibrated points 500 cycles apart, 10 subdivisions were required. Since it was expected that a large number of these oscillators would be manufactured, considerable effort could be justified in attempting to reduce this calibration time.

[1] RECORD, *October*, 1945, *page* 60.
[2] RECORD, *May* 1942, *page* 227.
[3] RECORD, *May*, 1939, *page* 291.

As a result, an automatic method[4] of calibration was developed. A film scale for one oscillator was calibrated at 500-cycle points and then sub-divided by hand to give the 10 intermediate points 50 cycles apart. The other oscillators were then calibrated automatically against this master.

Although this method proved very satisfactory and considerably reduced the cost of calibration, it was felt that improvements would be required for a 20-megacycle oscillator recently developed, which was also to be reproduced in considerable quantities. A new automatic method of calibrating has therefore been developed. This method avoids the need for a master oscillator, and instead calibrates each oscillator automatically against the Bell System standard frequency, thus simplifying the process and securing greater accuracy.

The method is shown in block schematic form in Figure 1. In its major features it is similar to that used for the 17-B oscillator in that the film for the oscillator being

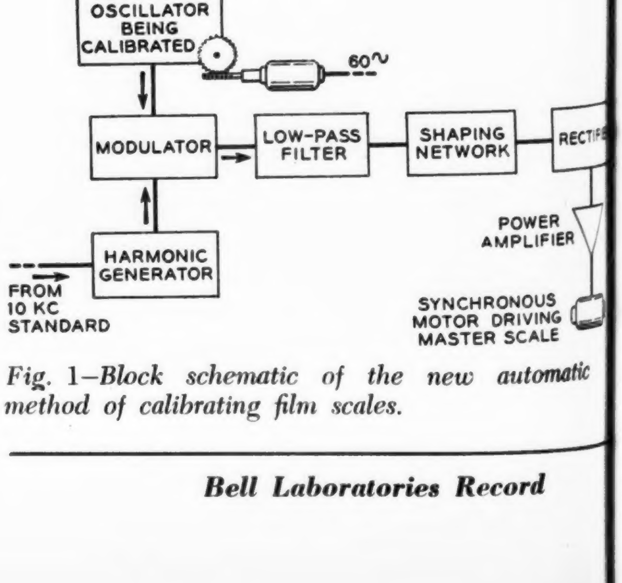


Fig. 1—Block schematic of the new automatic method of calibrating film scales.

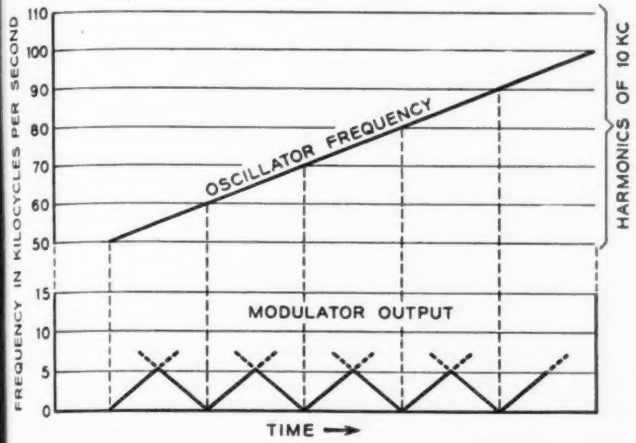


Fig. 2—Frequency-time graph of oscillator being calibrated, above; and frequency-time graph of output of low-pass filter, below.

calibrated is driven at constant speed and is printed from a master film scale, the speed of which is varied to bring the scale marks to the proper position opposite the film being marked. No second, or master oscillator is required, however, and the master film is uniformly marked over its entire length. This master film was economically produced by drawing a short section of uniform scale ten times the actual size and then repetitively photographing this section onto a film by professional cartoon animation equipment. The numerals were then dubbed on.

With this new calibrating system, the scale film of the oscillator being calibrated is driven at constant speed from the 60-cycle power supply, and as it is being driven, the oscillator frequency is continuously compared with the Bell System standard frequency. From this comparison an alternating current is generated that is applied to the motor driving the master scale. The frequency of this current is of just the right value to move the master scale 1 scale division, the equivalent of 10 kc, for each 10 kc increase in the frequency of the oscillator that is being calibrated.

To secure this value of the frequency, the 10-kc standard frequency is passed through a harmonic generator that produces a set of 10-kc harmonics of approximately equal amplitude and extending above 20 megacycles. This group of harmonics and the output of the oscillator under calibration are both fed to a modulator. The output of the modulator is passed through a low-pass filter with a cut-off at 5 kc.

As the oscillator is driven steadily toward higher frequencies at a rate of 75 kc per second, its output frequency is as indicated by the straight line shown in the upper part of Figure 2. The harmonics of the standard frequency with which it beats in the modulator are indicated by the horizontal lines on the same diagram. Each time the oscillator curve crosses one of these lines representing the harmonic frequencies, the output from the low-pass filter is at 0 frequency. Following each point of 0 frequency, the output frequency from the filter will rise linearly up to 5 kc, at which point the filter cuts off. At this point there are two 5-kc components: one resulting from the oscillator beating with the harmonic next below it, and the other from the oscillator beating with the harmonic next above it. As the oscillator frequency continues to rise, the beat frequency product from the lower harmonic rises above 5 kc and is eliminated by the filter, while that from the harmonic above the oscillator frequency decreases, becoming 0 as the oscillator frequency reaches the next multiple of 10 kc. The output from the low-pass filter is thus as shown

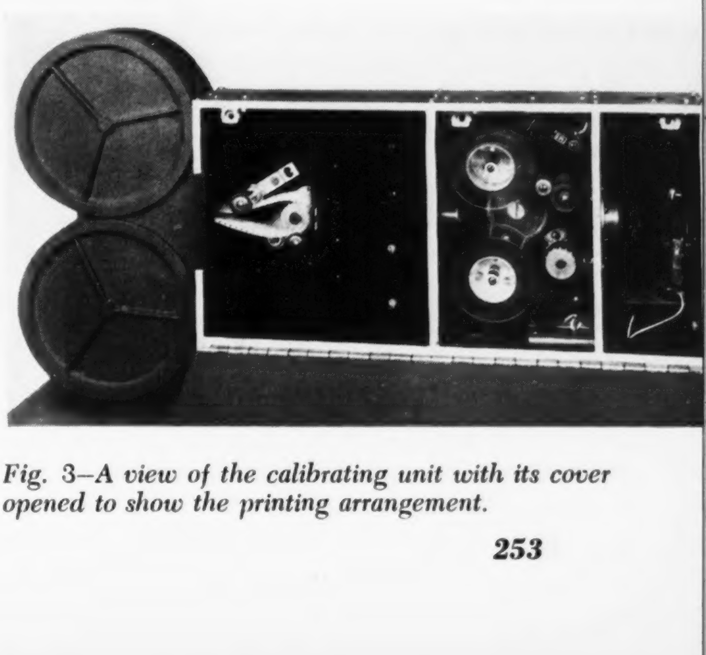


Fig. 3—A view of the calibrating unit with its cover opened to show the printing arrangement.

[4] Record, *July*, 1942, *page* 270.

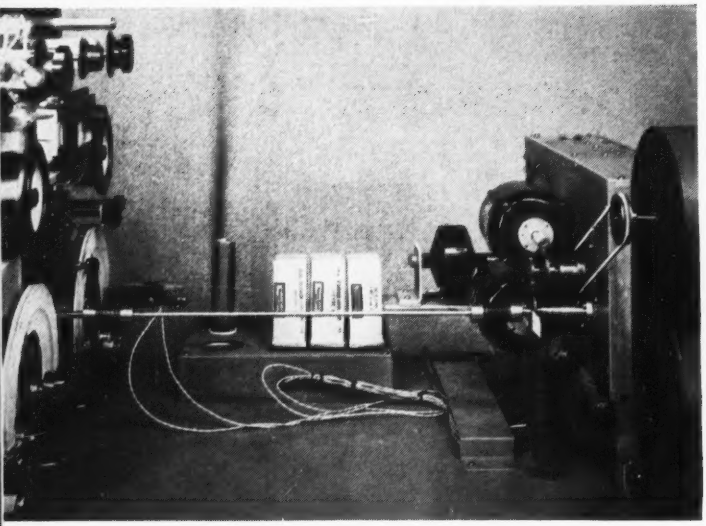


Fig. 4—During a calibration, the calibrating unit is directly coupled to the oscillator being calibrated, which is placed facing it on a table.

in the lower part of Figure 2 on page 253.

Following the low-pass filter is a shaping network that has transmission peaks at 1.25 and 3.75 kc, and points of 0 transmission at 0, 2.5, and 5.0 kc. As a result the increasing and decreasing frequency output from the low-pass filter is suppressed in the vicinity of 0, 2.5, and 5.0 kc, and allowed to pass in the vicinity of 1.25 and 3.75 kc. Each 10 kc, therefore, there are four peaks and four zeros of output, and since 10 kc is passed over in 1/7.5 seconds, there are four times 7.5, or thirty, pulses per second. When this output is rectified, the result is an output voltage of approximately 30 cycles.

If the frequency of the oscillator being calibrated increases at exactly 75 kc per second, the output frequency from the rectifier will be exactly 30 cycles per second, and the motor will drive the master film one of the 10-kc divisions for each four cycles. Although the speed of the motor driving the oscillator under calibration remains constant, the output frequency of the oscillator will not increase uniformly at the rate of 75 kc per second because of irregularities in the tuning capacitor and its drive. When the rate is less than 75 kc per second, the rectified output voltage from the shaping network will be less than 30 cycles per second, and the master film will be driven proportionately slower;

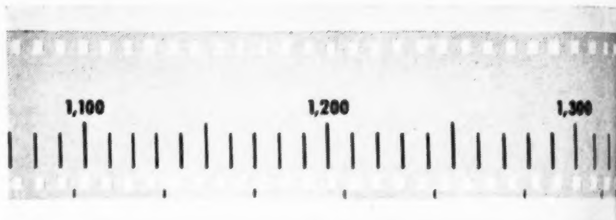


Fig. 5—A section of a film calibrated by the new method.

when the rate is greater than 75 kc per second, the frequency will be greater than 30 cycles and the film will be driven proportionately faster. The master film thus always moves in synchronism with the actual frequency at the oscillator, and thus the film printed is a true calibration of the oscillator. The complete calibration of a 25-foot film is made in less than four and one-half minutes.

All of the optical and mechanical appa-

THE AUTHOR: T. Slonczewski has been a member of the Technical Staff of the Laboratories since he received the degree of B.S. in Electrical Engineering from the Cooper Union Institute in 1926. He was at first engaged in the development of alternating-current bridges but has for some years devoted his attention to the study of oscillator and other electronic circuits. He has been responsible for the design of a number of oscillators that have been used for testing purposes in the Laboratories and in the field. He holds a number of patents covering various phases in the measurement field. Mr. Slonczewski has done considerable graduate work at Columbia University during the time he has been with the Laboratories.

ratus required for calibrating the film is mounted on or within the three-compartment metal camera cabinet, designed by J. C. Vogel, shown in Figure 3. In the photograph the cover has been opened to show the printing lamp in the right-hand compartment, the master film and associated apparatus in the middle compartment, and the sensitive film being calibrated at the left. The motors that drive both the master film and the film being calibrated are mounted on the other side of this camera and shown in Figure 4. The oscillator to be calibrated, shown at the left of Figure 4, is mounted facing the calibrating unit, and its drive is coupled to the drive for the film being calibrated as shown.

Experience with this equipment has shown that the error of the calibrating system alone is less than 1 kc over the range from 50 to 20,000 kc. This is less than the error with which the setting of the oscillator can be duplicated. Obvious advantages of this system are that it eliminates the drudgery and the opportunity for personal errors involved in a hand calibrated scale. In addition, the calibrated scale produced, shown in Figure 5, is not only more accurate but is better in appearance than the 17-B oscillator scale photographed from the hand calibrated master. At the same time, since calibration can be affected in five minutes or less, a controlled-temperature room is unnecessary.

New Transmitter Tester

When a telephone set is removed from service for any reason, it is subjected to routine tests for performance before being put back in service. Most of this reconditioning work is done by Western Electric's 29 distributing houses to which several million handsets are returned annually for examination. In working out ways and means for doing this work faster and more efficiently Western Electric cooperates closely with Laboratories' engineers whose specialty is the development of repair and maintenance methods.

A recent product of this cooperative effort is the new Western Electric tester for F1 transmitters shown at the right. The transmitter is coupled to an artificial mouth —a loudspeaker unit—which produces a signal which swings 15 times per second over a frequency band from 600 to 1600 cycles. If the transmitter meets its minimum efficiency requirements an indicator lamp lights up. The test takes about five seconds.

The basic test method was worked out at the Laboratories with the test set shown on the cover of this issue. More elaborate and flexible, the Laboratories set is used to test transmitters of all types over wider frequency ranges. Western Electric's version is streamlined to make a quick "yes or no" judgment of the transmitter.

To test a transmitter unit this Western Electric operator mounts it in a test fixture. She then swings the fixture around to face the artificial mouth underneath at 45 degrees, the angle at which transmitters are normally held in service. An essential feature of the test, the swinging action makes sure that the carbon granules are always shaken down in a uniform manner before measurement. (Courtesy of the Western Electric News)

An 8,000-cycle sound spectrograph

O. GRUENZ
Transmission Research

A sound spectrograph, such as shown in Figure 1, is a wave analyzer that produces a permanent record showing the distribution of energy in a complex signal either as a function of both frequency and time, or as a function of frequency at predetermined periods in time. The first type of portrayal, known as a spectrogram, is illustrated by the two upper graphs of Figure 2. In such spectrograms, frequency is displayed along the vertical axis, time along the horizontal axis, and intensity by the darkness of the pattern. The second type of representation, known as an amplitude section, is shown by the bottom graph of Figure 2. Here frequency is along the vertical axis as in the spectrogram, but the amplitude is indicated by the horizontal length of the markings at the various frequencies. The markings at zero frequency are reference lines and are not a part of the spectrum. Each section represents the amplitude-frequency distribution at the point of the spectrogram that is vertically in line with its left edge.

Fig. 1—The three units of the 8,000-cycle spectrograph as manufactured under a Western Electric license by Kay Electric Company, Pine Brook, N. J.

Developed during the war period, the spectrograph was publicly demonstrated in 1945. In the model* shown at that time, the frequency range extended to 3,500 cycles. Since then, an improved spectrograph has been developed in which the frequency range is extended to 8,000 cycles. The 8,000-cycle frequency scale is 4 inches high, and the length of the chart is 12½ inches.

The intensity range that can be displayed by variations in density of the markings on the dry facsimile paper employed is not only very limited, but also is difficult to translate into amplitude. The section avoids this limitation by allowing a horizontal distance of 1½ inches to display the full 35-db range in intensity. For detailed analysis of the intensities at various frequencies of speech, the section is the most useful form of presentation, but in studies of the general distribution of frequency and energy in speech, the spectrogram is more helpful.

To enhance its usefulness in the study of speech, the spectrograph is designed to give either of two types of spectrograms: narrow-band and broad-band representation. One is illustrated at (a) Figure 2, and the other at (b). The significance of these two types of representation will become evident from the description of the reproducing process.

A simplified block schematic of the sound spectrograph is shown in Figure 3. The signals to be analyzed, taken either from a microphone, as shown in the illustration, or from any other source, are applied to the record-reproduce amplifier to be recorded on the edge of the recording disk, which is plated with magnetic material. During the recording process the bias-erase oscillator provides a current to the erase head to remove any signals previously recorded on the disk. At the same time, the oscillator supplies a small amount of current through a high resistance to the record-reproduce head to provide a suitable bias.

* RECORD, *December* 1945, *page* 483; *and January* 1946, *page* 7.

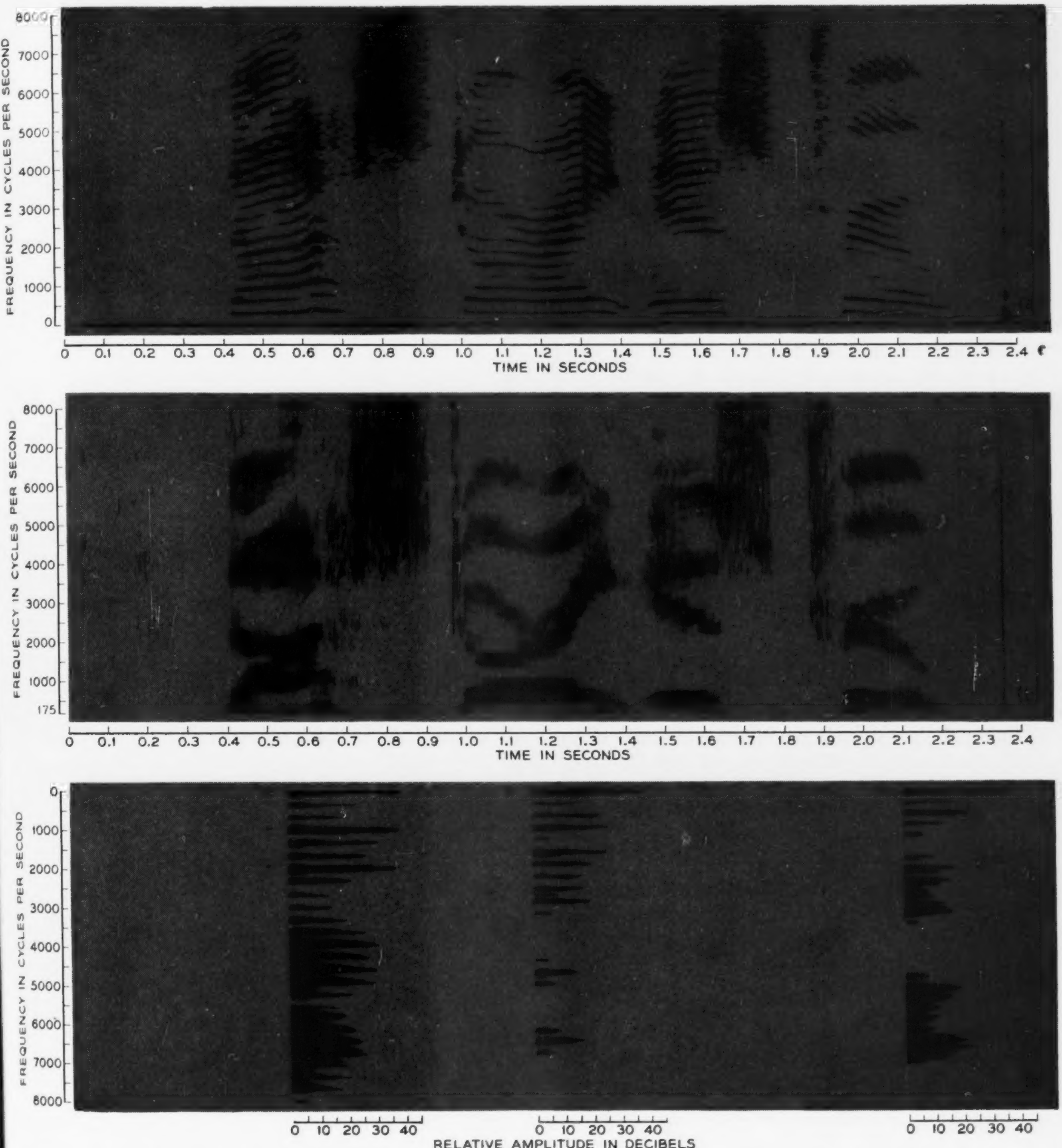


Fig. 2—The three forms of reproductions obtainable from the 8,000-cycle spectrograph; (a) narrow-band spectrogram; (b) broad-band spectrogram; (c) section.

After the desired signal has been recorded, the record-reproduce amplifier is switched around in the circuit so as to amplify the signals from the record-reproduce head before they are applied to the modulation system. During the reproducing process the speed of the disk is increased by a factor of three and a third and the bias-erase oscillator is made inoperative. A double modulation system is used with a variable frequency carrier that sweeps through its range as the stylus travels upward on the recording paper, and a second carrier having a fixed frequency. In this scheme the reproduced

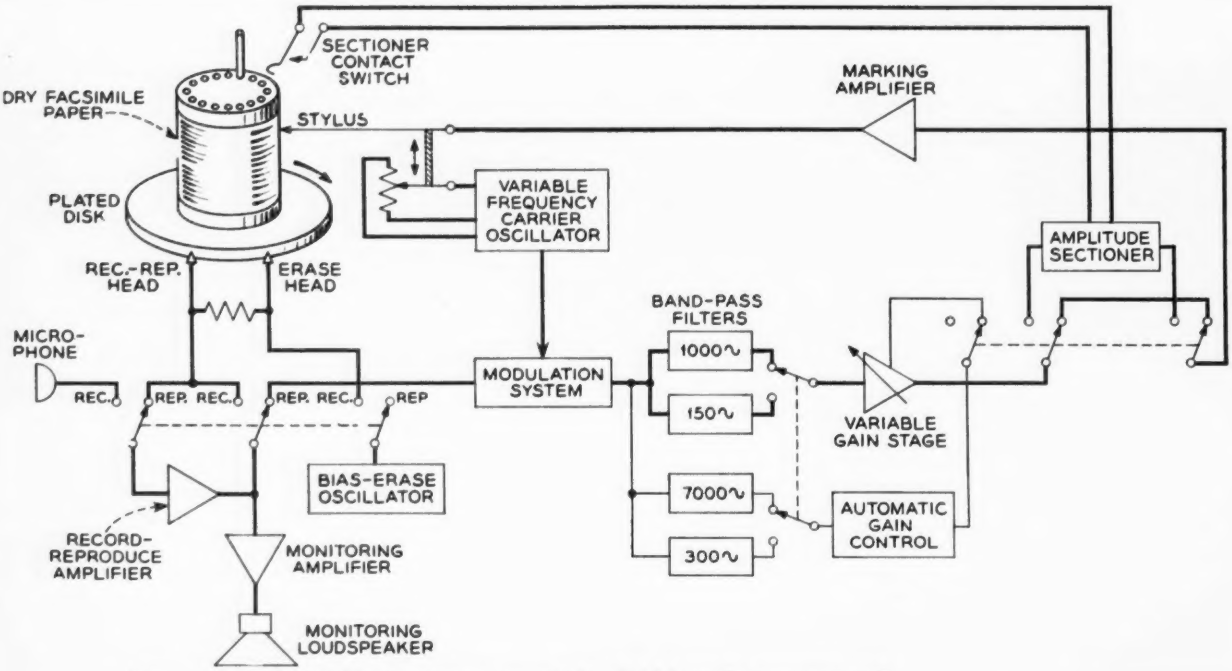


Fig. 3—Simplified block schematic of the 8,000-cycle spectograph.

signal band, which is three and a half times the original signal band due to the increased disk speed, is shifted upward by an amount depending on the frequency of the variable carrier oscillator and then brought down into the range of the analyzing filter by the second fixed carrier modulator. The over-all effect of this heterodyning process is to bring those frequencies of the signal band corresponding to the calibrated location of the stylus to the center of the fixed analyzing band-pass filter located at 20 kc.

Following the modulation system, the signal is applied to either of the two analyzing band-pass filters, both of which have their pass bands centered at 20 kc. One filter, which gives the narrow-band portrayal, has an effective band width of 45 cycles in terms of speech frequencies, while the other, giving the broad-band portrayal, has an effective band width of 300 cycles in terms of speech frequencies. Since the speed of the disk is increased three and a third times for reproducing, the frequency bands of the filters are about 1,000 cycles and 150 cycles.

Following the analyzing filter is a variable gain amplifier regulated by the automatic gain control circuit. Variable gain is required because of the limitations in intensity range of the paper on which the spectrogram is recorded. The intensity range of the components of speech is very much wider than can be reproduced on the chart. If the amplifier were set to reproduce properly the louder portions of speech, the weaker portions would leave no record at all. Similarly, if the gain were set to properly reproduce the weaker parts of speech, the louder parts would be far beyond the capabilities of the paper. To avoid this difficulty, the variable gain amplifier is automatically set for a gain that will satisfactorily reproduce the average intensities of only the frequencies in the neighborhood of those being reproduced at the time. For the broad-band portrayal, the input to the control circuit is taken from the output of a 14-kc to 21-kc band-pass filter. Although this is a 7-kc band, it represents only a 2.1-kc band of the speech frequencies because of the three and a third speed-up during the reproducing process. For the narrow-band spectrograms, the signal for the automatic gain control circuit is taken from a narrow band 300 cycles wide (90-cycle speech band), again centered around the analyzed frequency that is analyzed.

If the output of the analyzing filter is connected directly to the marking amplifier,

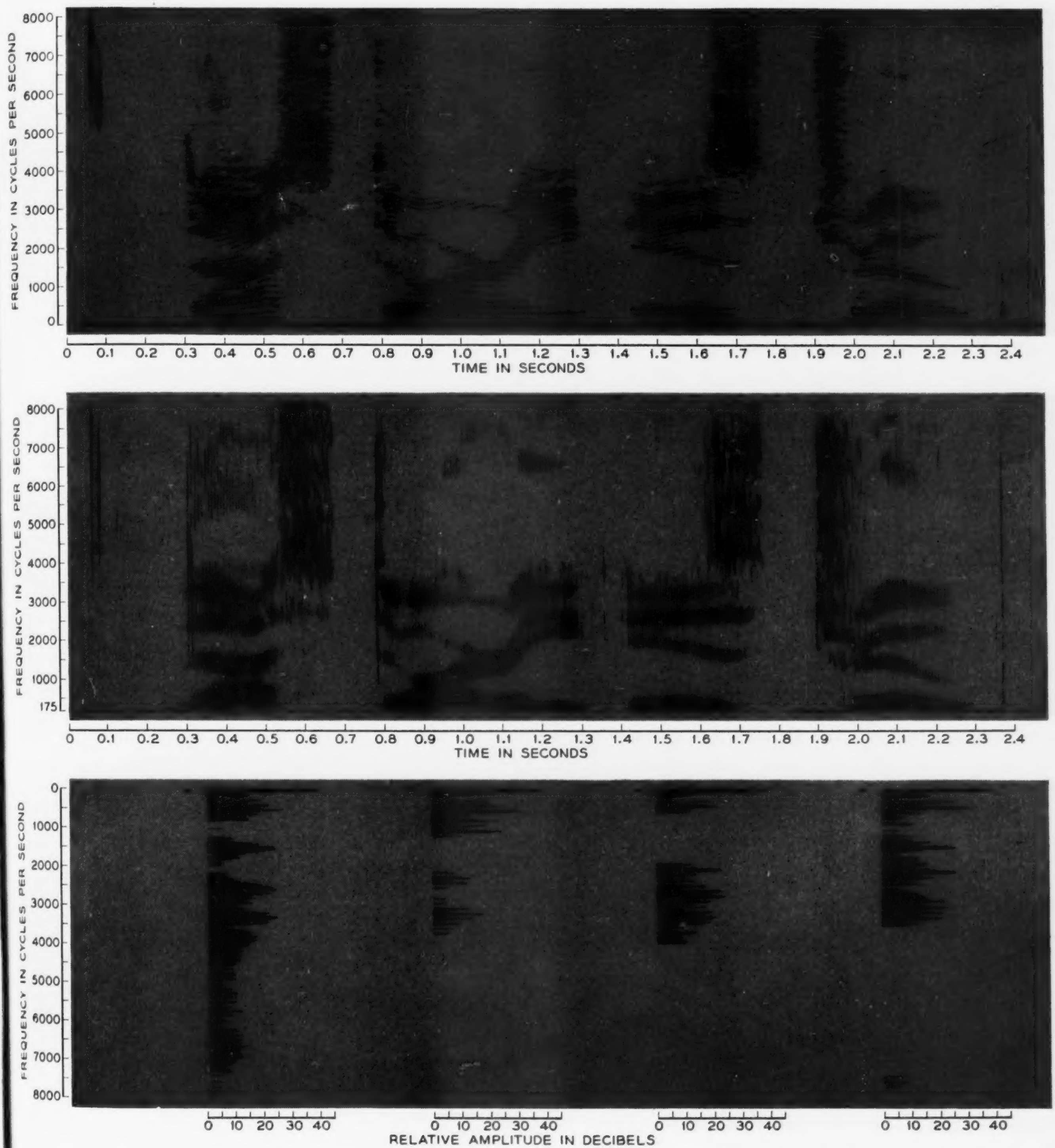


Fig. 4—Spectrograms and sections of "The Story Is True" as spoken by a male voice.

a spectrogram is traced on the recording paper. If the sectioner is placed between the analyzing filter and the marking amplifier, a section will be portrayed on the facsimile paper.

The stylus that marks the recording paper is linked mechanically with the slider of the potentiometer that varies the frequency of the carrier oscillator. At the low position of the stylus, the carrier oscillator frequency is such that the low frequency components in the reproduced signal, which are in the

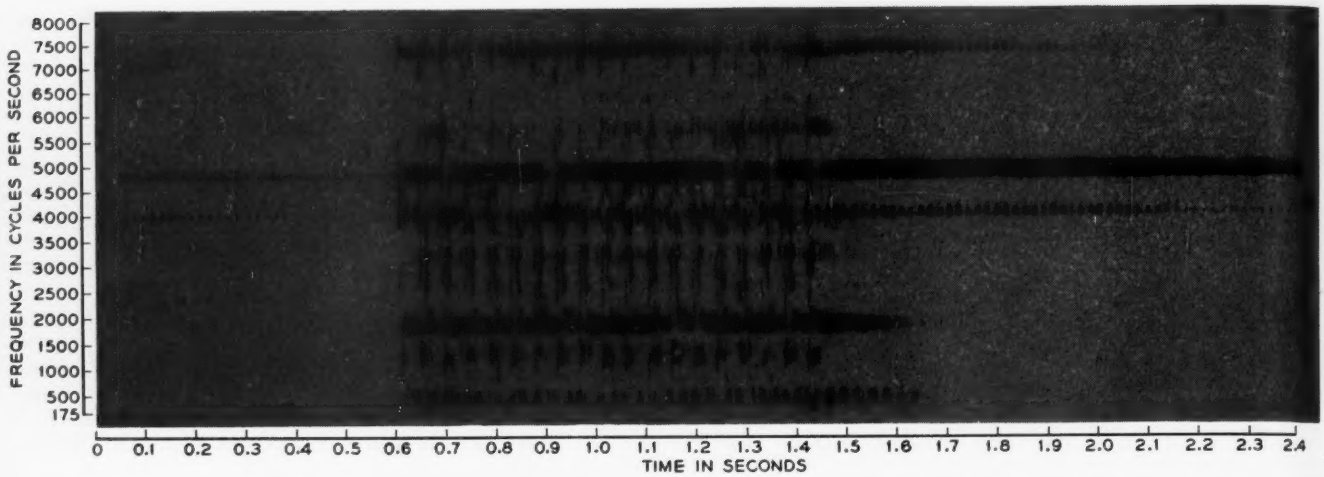


Fig. 5—Wide-band spectrogram of the ringing of a telephone bell.

order of 50 cycles in the original recorded signal, pass through the analyzing filter. At the top of the stylus excursion, the carrier oscillator frequency is such that the frequency corresponding to 8,000 cycles is passed by the analyzing filter.

To make the second type, or section, portrayal, the amplitude sectioner is switched into the circuit between the variable gain stage and the marking amplifier, and at the same time the automatic gain control feature is disconnected from the variable gain stage, and a fixed bias introduced in its place to hold the gain constant. The sectioner integrates the energy over a 5-millisecond period at a selected point of the spectrogram, and this energy then determines the length of time that a multi-vibrator is kept in operation. The points at which the sections are taken are determined by pins inserted in holes in the top of the drum that holds the facsimile paper. Each pin closes a contact at each revolution of the drum to actuate the sectioner so that it gives an output pulse whose duration is proportional to the logarithm of the sectioner input voltage over a range of about 35 db. Since the chart is 12½ inches long and each section is allowed about 2 inches for its amplitude portrayal, as many as six sections may be placed on a single chart.

The 8,000-cycle spectrograph is shown in Figure 1. It consists of three units: a turntable and chart unit, a control unit, and a power supply unit.

Although most of the use to which the sound spectrograph has been put is the study of speech, it is by no means limited to this field. The increased band width portrayal by this machine, however, should be of considerable advantage in speech studies. Figure 2b, for example, is a spectrogram using the wide analyzing filter for scanning "The story is true" as spoken by a child's voice. This shows that some of the resonance regions lie well above the 3,500-cycle upper limit of the earlier spectrographs. Likewise the stops and fricatives show up to much better advantage with the 8,000-cycle range. In the narrow-band portrayal, these resonance regions are not as clearly defined, but the individual harmonic structure and its variations are well defined. The differences between a child's voice and a male adult voice can be seen by comparing Figure 2b with the same sentence as spoken by a male adult voice as shown in the middle graph of Figure 4. In the wide-band portrayal it can be seen that with the child's voice the resonance regions are much higher than for the male voice. In the narrow-band pictures (top graphs of Figures 2 and 4) it should be noticed that the horizontal markings are much closer together, indicating a lower fundamental frequency for the male voice. At the bottom of both Figures 2 and 4 are shown sections that represent the energy distribution at the point of the spectrogram that is vertically in line with its left edge. This type of portrayal can be used to show the resonance regions of the sound at that particular point, as well as the frequency positions of the harmonics.

Examples of the use of the spectrograph

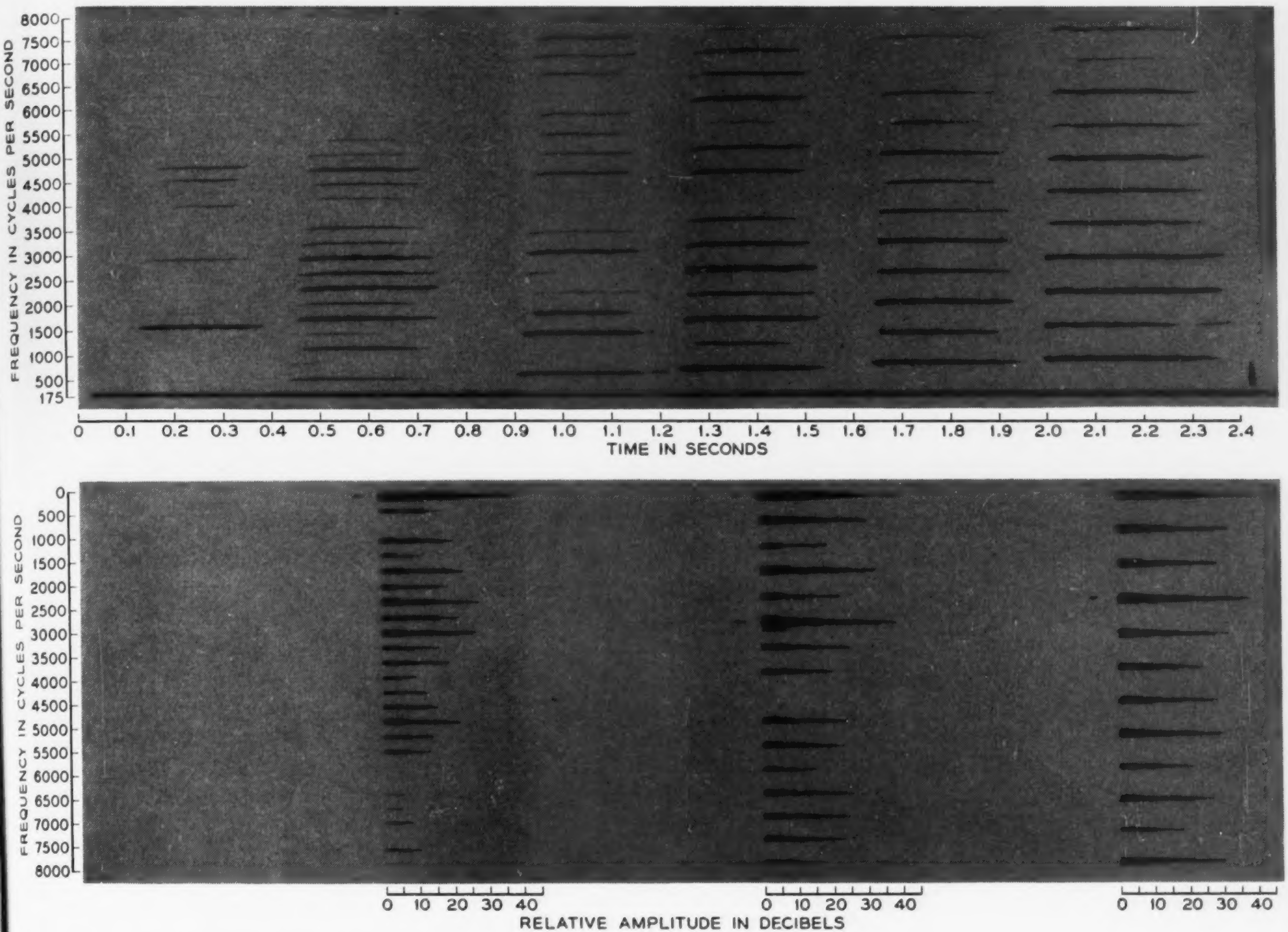


Fig. 6—Narrow-band spectrogram and sections of six notes of a harmonica.

in fields other than speech are shown in Figures 5 and 6. Figure 5 shows a wide-band spectrogram of the ring of a telephone bell. This shows the one-second period during which the clapper vibrates and then shows the decay of the ring of the bell. Figure 6 shows a narrow-band spectrogram of six notes produced by a harmonica together with sections taken during three of the notes. These sections show the fairly equal energy distribution of the harmonics.

These samples show a few typical uses to which the sound spectrograph can be put, but will serve to suggest many other applications to which the instrument would be applicable.

THE AUTHOR: Joining the Research Department of the Laboratories as a Technical Assistant in 1929, O. Gruenz first engaged in articulation tests of telephone systems. From 1937 to 1941 he worked mostly on the voder and vocoder, and then undertook war work for the next four years. Following the war, he worked on visible speech and later on the spectrograph development, but has recently again turned to military developments. In 1940 he received a B.S.E.E. degree from the Polytechnic Institute of Brooklyn.

Zinc plating grows a beard

Some three years ago, a puzzling phenomenon was encountered on some precision electrical filters of the hermetically sealed type. A few months after construction, some of these filters showed abnormally high transmission losses to low level currents. A conducting path within the filter from one of the three air condensers to ground would result in the high pass-band loss indicated. Attempts to locate such a condition proved fruitless at first, since most frequently the trouble cleared while the cover was being removed from the filter. One day a chance gleam of light revealed a very fine "whisker" reaching from the mounting bracket to the supporting stud of an air condenser. A paper knife was inserted between the condenser and bracket, breaking the whisker and immediately clearing the trouble, and thus the cause was found.

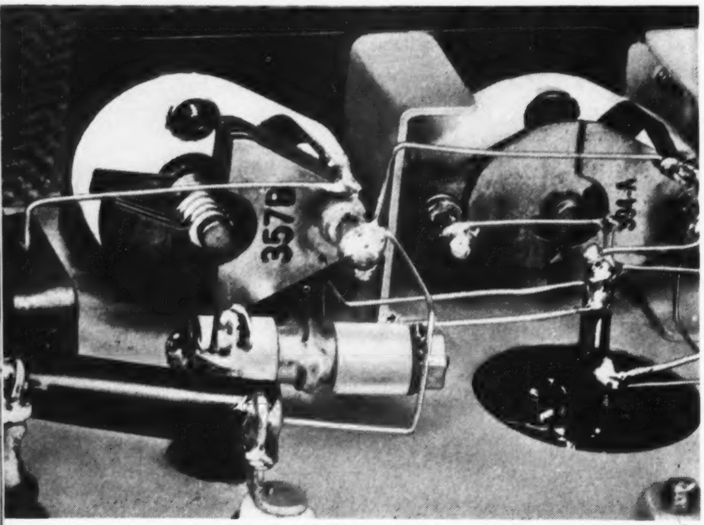


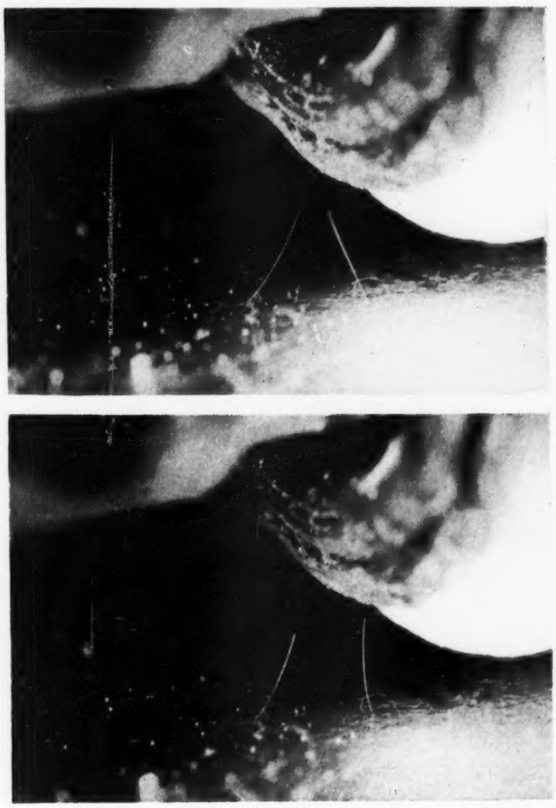
Fig. 1—Zinc whiskers grow from the zinc plated U-shaped bracket between the air condensers.

A more careful microscopic examination of the metallic surfaces of this and other filters revealed the presence of a whiskery growth attached to the zinc plated surfaces. The whiskers were of approximately uniform diameter for their entire length and were good electrical conductors. Photomicrographs on slides taken at 500X and projected to give an image 6000X showed that they were of a uniform diameter of only about one micron—less than 0.00004 inch. Some were at least ⅜ inch long. Although they are normally invisible, they have a very shiny surface, and it was the reflection from this surface that first revealed them.

No such growth had ever been encountered on zinc plate before, although it was known that whiskers of this general type had been found growing from cadmium plated surfaces. The familiar corrosion products of zinc consist generally of a white powdery substance. This bears no resemblance to this whiskery type of growth.

On these filters, three air condensers are fastened to a common plastic base that is secured to the mounting panel of the filter by two U-shaped brackets passing between the middle condenser and the two end ones, as shown in Figure 1. These brackets are

Fig. 2—Top, three long whiskers—one bridging the gap between condenser and ground—magnified 15X; bottom, same view as above after application of 135 volts d-c between filter terminals and ground.



zinc plated steel, and pass within about ¼ inch of the studs that carry the condenser plates. It is from these brackets and the zinc plated mounting plate that the whiskers grow and may make contact with other parts of the filter. Figure 2 is a photograph fifteen times actual size showing some of the whiskers running from the zinc plated brackets in the lower part of the photograph to a metal fitting on the condenser stud. Tests by E. S. Willis showed that their resistivity and temperature coefficient of resistivity are roughly of the same order as that of pure zinc. He has also shown that by the application of a small voltage to the filter terminals, the shorting whiskers could readily be burned off. The two views of the filter in Figure 2 were taken immediately before and after applying 135 volts d-c to the terminals of the filter. Contact has been broken as shown in the lower view.

Zinc has been and is being used widely as a protective coating for steel and because of its electrochemical protection has proved quite satisfactory. The growth of whiskers from zinc plating seems to be an unusual occurrence which takes place only under special conditions. It has been under investigation by the Chemical Laboratories to determine the composition of the whiskers and the factors controlling their growth. Whiskers appear to be pure metal, and they have been grown from zinc, cadmium, and tin plated surfaces. Of the more common types of metals used as a protective coating for steel, copper appears to be free of whiskers. Hence, copper is being used as a protective coating on steel in those applications where it is expected that the presence of whiskers would cause trouble. Such problems must be considered by the design engineer in the future.

How Your Telephone Service Grows

The Telephone Hour, April 9, 1951

A plainly dressed man, well past middle age, entered the lobby of the Bell Telephone System headquarters. In his hands were two paper bags which he pushed across the counter. They were stuffed with money—crumpled five, ten and twenty dollar bills. He had come there to invest his savings in the communications business that serves all America.

He was but one of thousands of men and women who came to that counter a month or so ago to take part in the largest single financing program in the history of American industry. Altogether 280,000 people, in person or by mail, invested more than four hundred million dollars in telephone company bonds. This brought to more than four billion dollars the amount of savings the American public has invested in the Bell Telephone System since the end of World War II.

How is all this money used? It goes to build new telephone exchanges; it goes into new cables and switchboards; it goes to improve your telephone service and to bring more telephone service to more people in cities and towns, villages and farms across America. It goes into new long distance lines—linking city with city and state with state—the lines that carry the orders and messages so important to the national defense program.

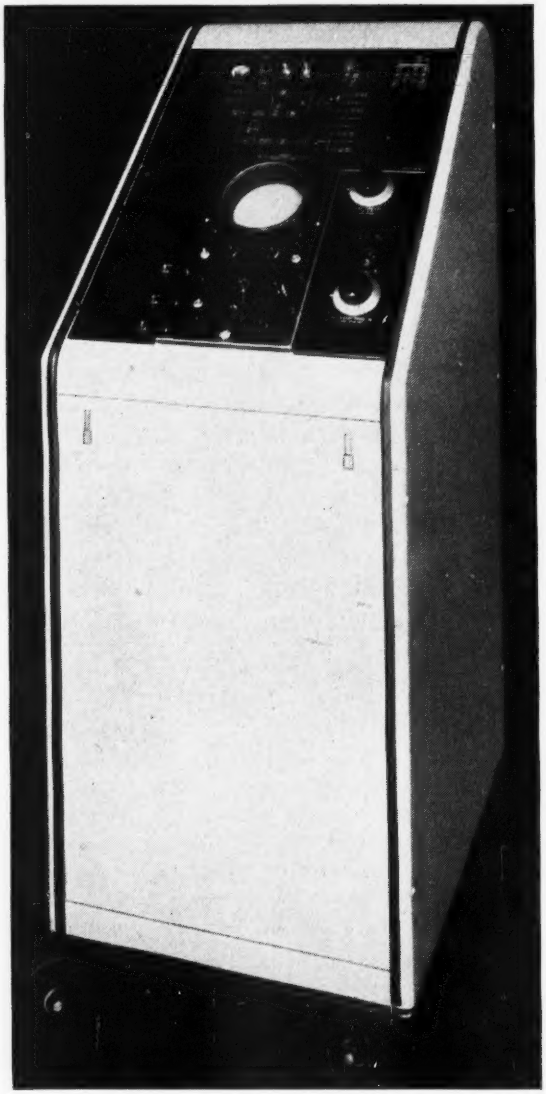
When people invest their savings in a progressive American enterprise, they share in the growth and development of our nation. When the savings of so many people are invested in a business, a great responsibility comes to those whose job it is to use the money. Telephone people, and there are more than 600,000 of them in the Bell System, recognize and accept this responsibility. And this acceptance becomes a pledge that the Bell System shall continue to improve and to extend its service to you and to all America.

Transmission measuring system

O. D. ENGSTROM
Transmission Development

It is well known that alternating currents of different frequencies are changed in magnitude and phase in varying degree as they progress along an unequalized transmission line. For years the telephone engineer has been concerned with correcting the attenuation distortions produced in lines in order to provide good quality speech, program and telephoto circuits. In some of these circuits he has also been concerned with distortions occasioned by variations in phase from the ideal, but these have been readily equalized because of the narrow band widths involved and the simpler phase variations encountered. With the advent of television transmission over the L1 coaxial system have come new transmission problems introduced by the very wide frequency bands used and the complex phase variations experienced.

Television signals consist of line and frame synchronizing pulses that occur repetitively at their respective rates, together with the interspersed picture information. Signals of this type may be thought of as being composed of a spectrum of sinusoidal frequencies harmonically related, each having a specific phase and amplitude relative to the fundamental. If such pulses are to be transmitted over a communication system without changing the original signal forms, there must exist a minimum of attenuation and phase distortion over a band that includes all the frequencies comprising the signal. For this reason, the design of the L1 coaxial system incorporates both attenuation and phase correcting networks, which have to be adjusted both at the time of system installation and from time to time thereafter to take care of changes due to temperature, aging, or circuit rearrangement.



The 46A transmission measuring console.

When the initial alignment of the L1 coaxial television system was made, a special group of engineers—called the "Blitz Crew" —adjusted the attenuation and phase equalization, or made measurements from which "mop-up" equalizers could be designed. This required detailed point-by-point measurements at closely spaced intervals in the frequency range of 200 kc to 3000 kc. Although attenuation measurements could be made with conventional transmission measuring equipment, phase measurements required a more involved setup, because the two ends of the system were remote from each other. The considerable effort expended in equal-

izing the networks was justified, however, by the results obtained, but it was obvious that day by day maintenance of the system required a measuring set both cheaper and easier to operate. The 46-type transmission measuring system was designed to fill this particular need.

A carrier transmission system said to have no phase distortion is one in which the phase shift varies linearly with frequency through the range covered by the carrier frequency and the sidebands. The straight line of Figure 1 illustrates the phase characteristic of such a system; the curved characteristic is for one having distortion. It should be appreciated that on a long line the voltage vector representing any one frequency will revolve through many thousands of degrees. From the distortion standpoint, however, only the phase shift differences between frequencies in the transmitted band need be considered, as illustrated by the increments $\Delta\theta_1$ and $\Delta\theta_2$. This is fortunate, because it would be difficult to measure the accumulated phase shift of a long line. As suggested by the curves of Figure 1, the distortion may be measured by the change in phase shift difference occurring in a relatively small frequency interval (in this case 200 kc*) centered at any frequency f_2, compared to that occurring in a similar interval centered at some reference frequency f_1. By plotting a succession of such comparisons over the entire frequency band, choosing the variable interval so that the lower frequency f_2' will coincide with the f_2'' frequency of the previous measurement, a complete phase distortion characteristic may be obtained. This characteristic is referred to as a "leg-over-leg" measurement, and will result in a measurement of the accumulated deviation from linear phase shift over the transmission band being studied.

If two frequencies, differing by a small amount, are transmitted simultaneously, a resultant wave is produced, the amplitude of which varies at a frequency equal to the difference between the two original waves. This wave is said to have "envelope modulation." When this difference (or envelope) frequency is received at the terminal end of the line, it will arrive at a different time if it is conveyed by frequencies f_1' and f_1'', than by f_2' and f_2'', because of the phase distortion indicated in Figure 1. The phase shift that occurs to the envelope is referred to as envelope delay, and may be defined as the rate of change of phase shift with respect to frequency. Mathematically, it is written as $d\beta/d\omega$, where the phase shift β is expressed in radians and the angular velocity ω in radians per second; the rate of change is, therefore, obtained in seconds. A close approximation to "envelope delay" is achieved by taking small uniform frequency intervals such as from f_1' to f_1'' and measuring $\Delta\theta_1$. The answer thus obtained, when comparing $\Delta\theta_2$ with $\Delta\theta_1$ is "envelope delay distortion," and is in degrees of the interval frequency, which may be converted to microseconds.

When the initial lineup of the system was made, the "Blitz" crew used a precise 50-kc interval envelope delay distortion measuring set in which the test and reference frequency pairs were transmitted simultaneously over the line and the phase difference of the envelope frequencies compared directly at the distant end. Elaborate and expensive test equipment was required, because it was necessary to minimize unwanted modulation frequencies, separate

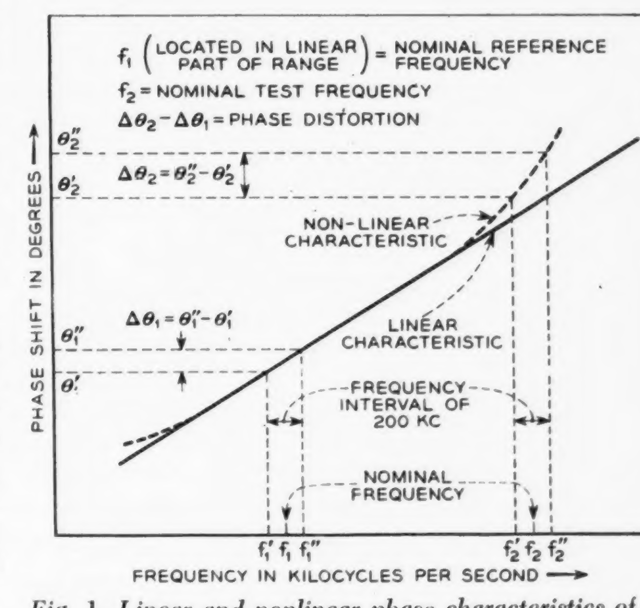
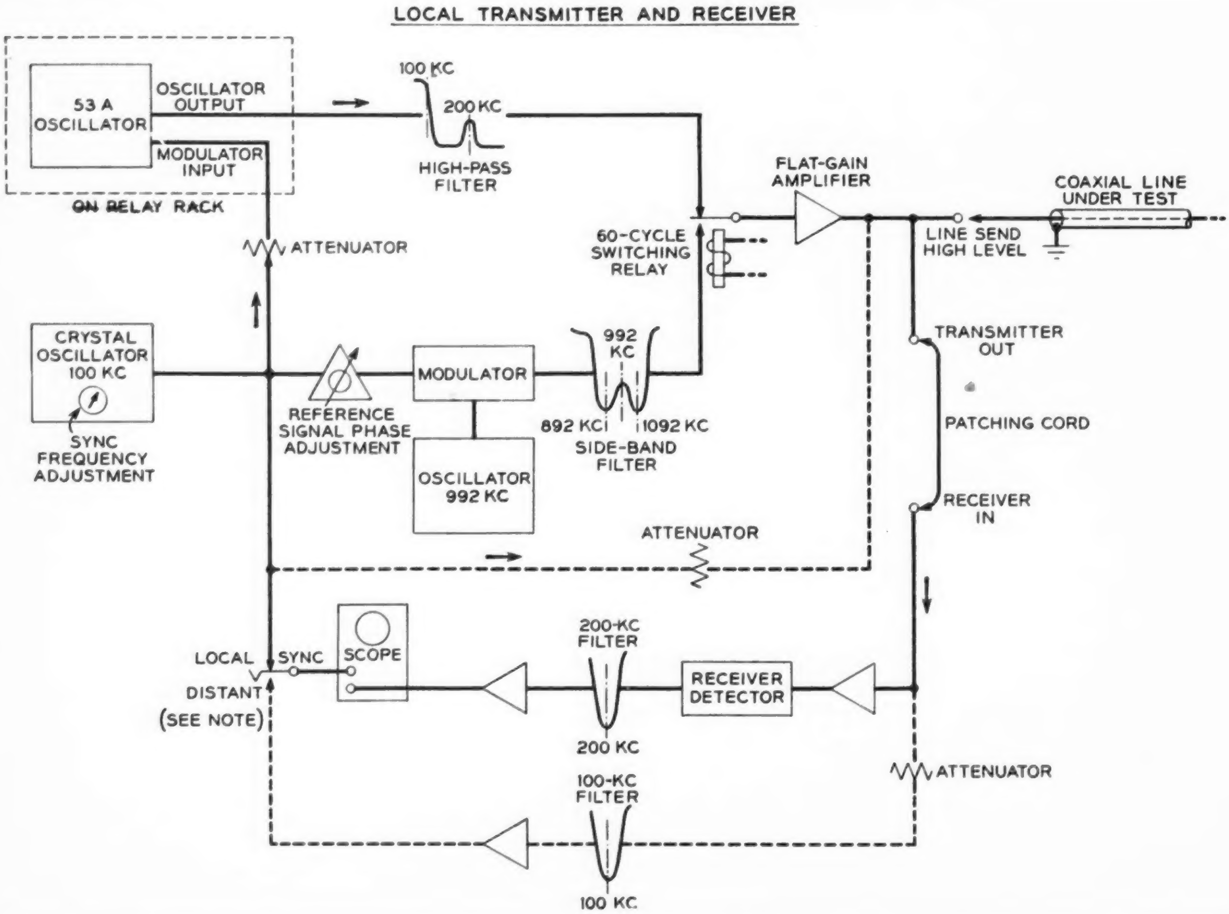


Fig. 1—Linear and nonlinear phase characteristics of a transmission system.

* For initial alignment, still smaller frequency intervals are used, giving a much finer grained phase distortion characteristic.



the two pairs of frequencies, and at the same time, not introduce undesired phase shifts.

In the 46-type measuring system (with a 200-kc interval), these complications were avoided by the use of "time division." Each pair of test or reference frequencies is put on the line alternately. Because of the persistence of the oscilloscope screen, the envelope frequency of each pair appears simultaneously against a common base line, thus permitting the direct measure of the phase difference existing between the two waves. A simplified circuit, entirely satisfactory for maintenance purposes, resulted.

Figure 2 illustrates the circuitry required to measure envelope delay distortion in the manner described. The 100-kc crystal oscillator in the transmitter generates a frequency which is one-half of the desired 200-kc interval. This frequency is connected through a variable phase shifter to a varistor modulator and 992-kc oscillator, which produce sidebands of 892 kc and 1092 kc, the carrier frequency of 992 kc being suppressed by the inherent balance of the modulator and in the filter that follows it.

A branch circuit from the 100-kc oscillator passes through an attenuator to the 53A heterodyne type oscillator. This oscillator generates two frequencies exactly 100 kc above and below the nominal frequency being used for the tests. Provision is made within the oscillator to suppress almost entirely the nominal frequency. The output then passes into the measuring set where a high pass filter suppresses spurious frequencies that have been formed in the oscillator circuits.

Thus, the transmitter produces two pairs of frequencies, one pair fixed at 892 kc and 1092 kc, and the other pair 100 kc above and 100 kc below the nominal test frequency being used. Each pair is alternately connected to the line under test through the contacts of a switching relay, at a 60-cycle

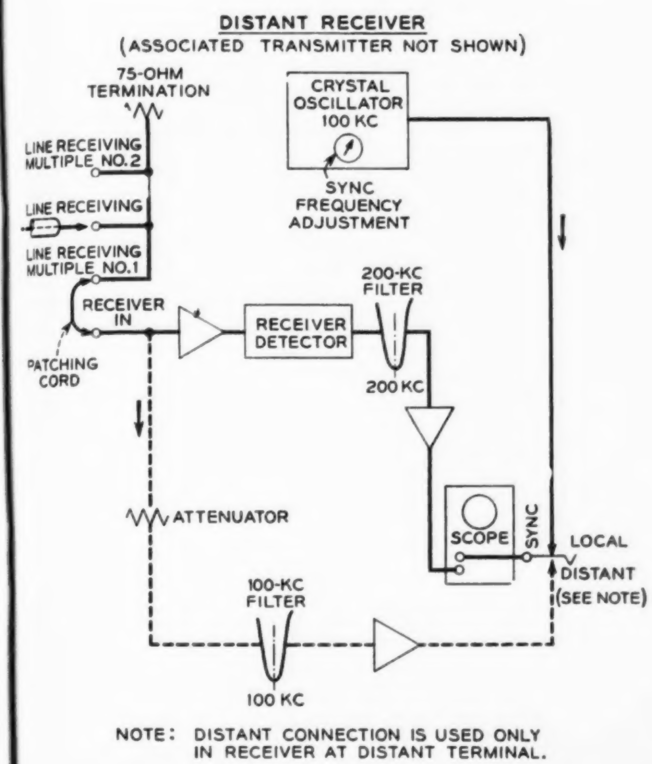


Fig. 2—Block schematic of the 46-type measuring system. The dotted lines indicate the modifications for distant end synchronization.

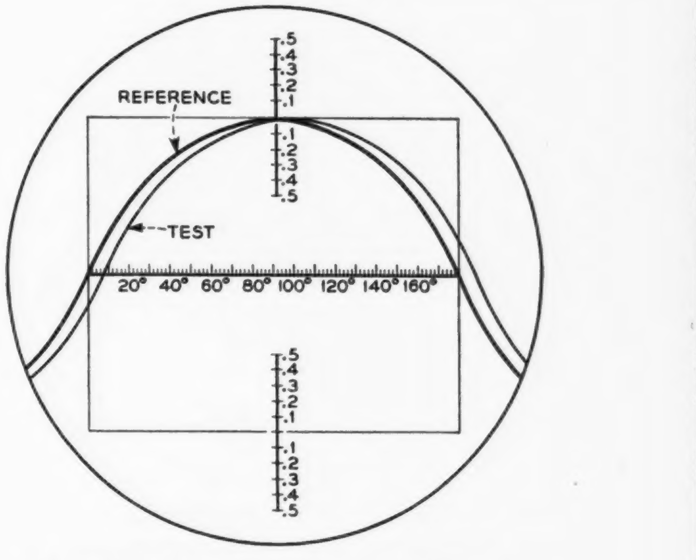
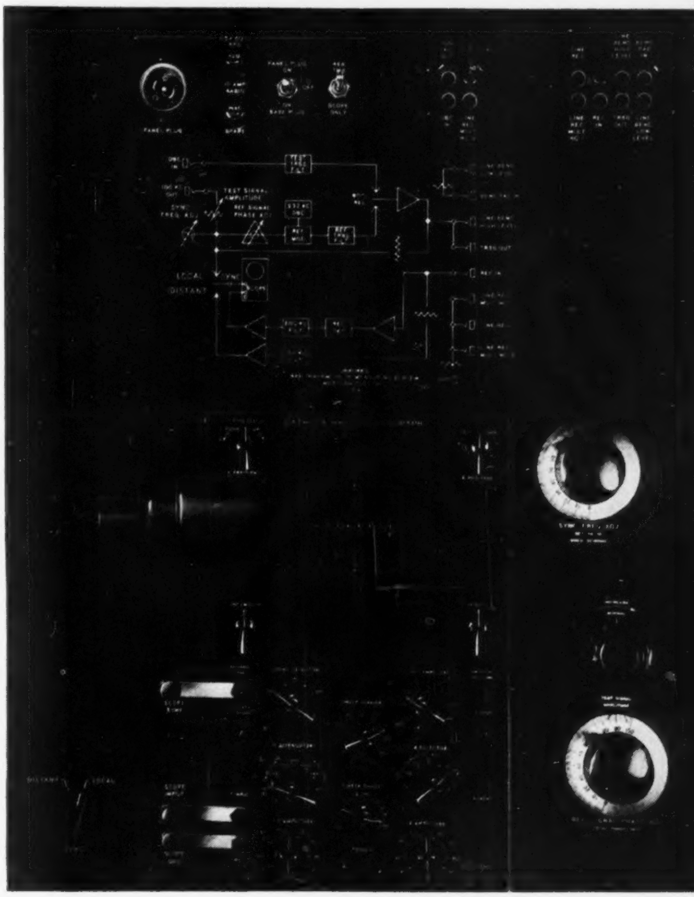


Fig. 3—Examples of oscilloscope pattern at receiving terminal, showing delay distortion.

Fig. 4—The control panel of the 46B transmission measuring system.



rate. A flat gain amplifier supplies the necessary gain to the signal.

Receiving circuits are also shown in Figure 2. The receiver at the transmitting end is used to monitor the outgoing envelope, adjustments being made at each test frequency setting to insure equal amplitudes of the envelopes. Phase equality is accomplished by adjustment of the REF SIGNAL PHASE ADJ dial.

Both local and distant receivers are designed to accept the two frequencies of a pair arriving at any moment, and demodulate them to produce their difference frequency of 200 kc. This signal then passes through a selective filter and amplifier to the vertical deflection plates of an oscilloscope. The horizontal sweep supplied to the oscilloscope is synchronized to give a superimposed display of one-half cycle of each 200-kc wave against a phase scale, as shown in Figure 3. To insure that the phase

differences appearing on the oscilloscope at the distant receiver are due only to distortions in the cable under test, the receiving circuits have been designed to be almost purely resistive, up to and through the demodulator so that the response will be the same for all frequencies.

The sweep frequency of each receiving oscilloscope is synchronized by its associated 100-kc crystal oscillator so that it displays approximately four cycles of the 200-kc envelope frequency. Then by suitable adjustment of the horizontal gain and positioning controls, one-half cycle of the reference envelope is fitted to the phase scale of Figure 3, which is calibrated from 0 to 180 degrees. Slight adjustments in the 100-kc oscillator frequency to obtain stationary wave patterns, can be made by means of the SYNC FREQ ADJ (synchronizing frequency adjust) dial on the crystal oscillators.

In the latest design, known as the 46B transmission measuring system, provision has been made to eliminate this synchronizing necessity. A low level of 100 kc is transmitted over the line along with the test frequencies, and rejuvenated at the receiving end in a separate circuit connected in parallel with the receiver input. These circuits are indicated by the dotted lines of Figure 2. The operator at the receiving end may select either local or distant synchronization by the operation of a panel switch designated SYNC. This feature was made optional to provide a safeguard against rapid phase variations (or "jitter") of the line at 100 kc, that may be experienced on circuits that are in trouble and in which cases, distant synchronization may be unusable.

A complete 46A transmitter and receiver mounted in a rolling console for mobility is shown in the headpiece. A close view of the operating panel of a 46B set is shown in Figure 4. The console combines convenient operating features with pleasing appearance. All controls are mounted in the sloping front panel and connecting jacks are located near the top, where cords may be draped over the back of the console out of the way. The oscilloscope is provided with a hood and light projected scale, as shown in Figure 4, designed to eliminate parallax and glare, thus facilitating reading. Besides having a phase calibration, the scale is equipped with amplitude marks that make it possible to estimate amplitude distortion in per cent—a feature that has proved valuable in attenuation alignment of a system, which normally precedes phase adjustment.

This test equipment is being provided at branching points on L1 coaxial lines carrying television programs. Field experience has already shown it to be an effective maintenance instrument and its circuit and operating simplicity have made it a popular servicing tool.

THE AUTHOR: Immediately after O. D. ENGSTROM received his E.E. degree from the Polytechnic Institute of Brooklyn in 1923, he came to the Laboratories. His first work was in the methods of operation group of the Systems Development Department, but the following year he transferred to the carrier group, where he became engaged in the initial development of the commercial long wave trans-Atlantic radio telephone circuits. Later on, he was concerned with the development of privacy systems for both long and short wave telephone service. About this time, he was placed in charge of a group working on a two-channel long wave radio system. Just prior to World War II, he worked on the development of specialized test equipment for carrier systems. During the war, his initial activities were in connection with an underwater detection system, then the Mark 12 radar indicating equipment and finally with microwave testing equipment. Following the war he returned to testing equipment development, especially for Video and coaxial circuits. More recently, he has been placed in charge of toll and radio signaling.

J. W. McRae

A. B. Clark

A. B. Clark Takes New Post; J. W. McRae Named Vice President

On June 1, Vice President A. B. Clark moved to a new Laboratories post in which he will coordinate all Bell System programs in the Laboratories. In his new position, Mr. Clark is responsible for the Laboratories' relations with the American Telephone and Telegraph Company and with the Western Electric Company on all Laboratories programs for the Bell System.

Also effective on the first of June, J. W. McRae was appointed Vice President and succeeds Mr. Clark in charge of the Systems Development organization. At the same time, this organization was divided into three general departments: Systems Engineering, Transmission Development, and Switching Development. The heads of these general departments will report to Mr. McRae.

G. W. Gilman has been appointed Director of Systems Engineering. The Directors of Switching and Transmission Engineering report to Mr. Gilman, who continues as director of Transmission Engineering.

M. B. McDavitt continues as Director of Switching Development, and the Directors of Switching Systems Development and Switching Apparatus Development continue to report to him. E. F. Watson was appointed Director of Telegraph Development, in charge of a new Department of Telegraph Development, and he and his present organization also report to Mr. McDavitt.

G. N. Thayer has been appointed Director of Transmission Development. The Directors of Transmission Systems Development, Transmission Apparatus Development, and Electronic Apparatus Development report to Mr. Thayer.

Alva B. Clark, a Vice President of the Laboratories since 1944, is a native of Ohio. He attended schools in that state and in Michigan, and graduated from the University of Michigan in 1911 with a bachelor of electrical engineering degree.

That year he joined the American Telephone and Telegraph Company as an assistant in telephone transmission engineering and development. From 1911 to 1934, when the Department of Development and Research of the Amer-

G. W. Gilman

M. B. McDavitt

ican Telephone and Telegraph Company was consolidated with Bell Telephone Laboratories, he was engaged in many phases of transmission development work, including telephone repeaters and their application to telephone lines, telegraph and signaling problems, and to the many complicated problems relating to inductive co-ordination.

Mr. Clark became Director of Transmission Development in June, 1935, and in 1940 he was named Director of Systems Development, in charge of the Systems Development Department handling transmission and switching systems development.

In 1944, Mr. Clark was made a Vice President of the Laboratories, in which capacity he continued his direction of the work of the Systems Development Department, with the additional responsibility of the Outside Plant Development Department.

Mr. Clark is a member of Tau Beta Pi and Sigma Xi; he is a Fellow of the American Institute of Electrical Engineers and the Acoustical Society of America; and is a member of the Institute of Radio Engineers and the American Association for the Advancement of Science. He has been Bell System chairman for many years of the Joint Subcommittee on Development and Research of the Edison Electric Institute and the Bell Telephone System.

James W. McRae has been with the Laboratories since 1937. He is a native of Vancouver, B. C., and received the Bachelor of Applied Science degree from the University of British Columbia in 1933, the M.S. degree in 1934 from California Institute of Technology, and a Ph.D. degree from the same institution in 1937.

His first work at the Laboratories was concerned with research on transoceanic radio transmitters. His next assignment was in the field of microwave research, which led naturally to work on military projects, including a special microwave oscillator for the National Defense Research Committee and early association with several microwave radar projects.

In 1942 he was commissioned a major in the U. S. Army Signal Corps and was assigned to the Office of the Chief Signal Officer in Washington, D. C. He remained in Washington for more than two years, engaged in coordinating development programs for airborne radar equipment and for radar counter-measures devices. He later received the Legion of Merit for his work on these programs.

In June, 1944, Mr. McRae was transferred to the headquarters of the Signal Corps Engineering Laboratories at Bradley Beach, N. J., as Chief of the Engineering Staff. Later he became Deputy Director of the Engineering Division and attained the rank of colonel be-

G. N. THAYER

fore returning to civilian life at the end of 1945. Returning to the Laboratories in 1946 he was appointed Director of Radio Projects and Television Research in which capacity he was responsible for work on the New York-Boston radio relay project. With the addition of responsibility for electron dynamics research in 1947, he became Director of Electronic and Television Research. In 1949 he was appointed Assistant Director of Apparatus Development and in March of that year, Director of Apparatus Development. In October, 1949, he became Director of Transmission Development.

Mr. McRae is a Fellow of the Institute of Radio Engineers and in 1949 was chairman of its New York Section. He is now a member of the Board of Directors and Executive Committee and of the Awards Committee. He is also a member of the American Institute of Electrical Engineers and of Sigma Xi, national science honorary society.

George W. Gilman began his telephone career in 1923 with the New England Telephone and Telegraph Company. Born in Nova Scotia, he was educated at Massachusetts Institute of Technology, where he received a bachelor of science degree in 1922 and a master of science degree the following year.

Engaged in transmission engineering with the New England Company, Mr. Gilman joined A T & T in 1929, concentrating his efforts on radio transmission problems in the Department of Development and Research. This department became a part of the Laboratories in 1934.

In 1938 Mr. Gilman went to London, where he served as Assistant Technical Representative in Europe for A T & T. He had previously served on the Pacific coast, the Far East and in Hawaii.

In 1940, Mr. Gilman became Radio Transmission Engineer, and in 1944, he was made Director of Transmission Engineering. During World War II, he served as a consultant to the National Defense Research Committee. In 1950, he was a guest lecturer in electrical engineering at M.I.T.

Marcellus B. McDavitt has been with the Bell System since 1925, when he joined the Department of Development and Research of the American Telephone and Telegraph Company. A native of Texas, he was graduated from the University of Virginia in 1924, with a degree in electrical engineering. In 1926 he received a master's degree in electrical engineering from Massachusetts Institute of Technology.

Mr. McDavitt's early work was concerned with the development of step-by-step dial telephone central office systems, the formulation of design requirements and the direction of numerous trial installations of new switching developments. When his department was made a part of Bell Laboratories in 1934, he continued in this work.

During the war, Mr. McDavitt concentrated on communication systems development and engineering on projects for the armed forces, including the development of air warning, tactical air control and other systems for the army, navy and marine corps. In 1945 he became Director of the Laboratories' School for War Training. From 1945 to 1947 he was Radio Transmission Engineer, and from 1948 to 1949, Assistant Director of Switching Engineering. Since 1949 he has been Director of Switching Development, responsible for all phases of local and toll switching development, including in addition to switching engineering, the development of apparatus for use in switching systems and development of complete switching systems comprised of circuits and equipments that are manufactured and installed by the Western Electric Company. Mr. McDavitt is

a Fellow of the American Institute of Electrical Engineers, and a member of the Institute of Radio Engineers, and Sigma Phi Epsilon, Theta Tau and Tau Beta Pi fraternities.

Gordon N. Thayer, who has been appointed Director of Transmission Development, has been with the Laboratories since 1930. A native of Colorado, Mr. Thayer attended high school in Montclair, New Jersey, and holds a degree in mechanical engineering from Stevens Institute of Technology.

In 1930, Mr. Thayer joined Bell Telephone Laboratories. From 1930 to 1940 his special interest was the development of mobile radio communication equipment and systems. In 1940, he became affiliated with a group developing radar systems. He later worked on microwave radio relay systems, and since 1949 he has been concerned with the development of communication systems, including work on the TD-2 microwave system, the Key West-Havana submarine cable, and overseas radio projects.

In January, 1949, he became Assistant Director of Transmission Development, and in October of that year, he was appointed Assistant Director of Transmission Systems Development. Mr. Thayer is a Fellow of the Institute of Radio Engineers.

ECA Award

The Bell Laboratories has received another Marshall Plan Certificate of Cooperation, awarded by the Economic Cooperation Administration in recognition of assistance given to visiting foreign experts brought to the United States to study American methods under the ECA Technical Assistance Program. The award was made at ceremonies in New York's City Hall April 19, at which time representatives of many fields of commercial, industrial, and labor endeavor in New York City, who have contributed directly to the economic recovery of western Europe, received certificates.

Laboratories' Books Honored

Three recent books in the Laboratories' series have been honored by being included on the 1950-51 list of 100 best scientific and technical books of the year. This list is prepared by R. R. Hawkins, Technical Librarian of the New York Public Library, and is published in the May 15 issue of the *Library Journal*. The books included are *Electrons and Holes in Semiconductors*, by W. Shockley, *Traveling Wave Tubes*, by J. R. Pierce, and *Principles and Applications of Waveguide Transmission*, by G. C. Southworth. The selection of the 100 best technical books of the year is an annual event. Last year, the book entitled *Acoustical Designing in Architecture*, by C. M. Harris in collaboration with Prof. V. O. Knudsen, UCLA, was honored.

Civil Defense Preparations at the Laboratories

Former First Aid Instructors were busily engaged in refresher courses both at Murray Hill and at West Street during April. The reactivated instructors will give standard first aid courses after their refresher work is completed.

The photograph, left, below, taken at Murray Hill, shows P. G. Clark, F. T. Wood, J. H. Bollman, M. L. Weber and C. F. Benner, preparing the "victim" of a back injury (R. N. Larson) for transport, using a back board and a blanket under the hollow of his back. Mr. Benner is the instructor, and is assisted by Mr. Weber, who is also a qualified instructor. C. E. Kempf, another qualified instructor, and J. Leutritz, Jr., a member of the refresher group, were absent when the picture was taken.

At West Street, the refresher group under the instruction of L. E. Coon, safety engineer (in rear), are transporting Georgine Fredericks on the stretcher. Miss Fredericks, a member of the group, has a simulated fractured ankle; this has been immobilized with a pillow. Carrying the stretcher are R. M. Hawekotte, W. G. Smith, A. C. Millard (partly concealed) and J. C. Morris. Not in the picture, R. P. Jutson is also taking the course.

Address of President Leroy A. Wilson at the Annual Meeting of A T & T Stockholders

Just three years ago I presided for the first time at an American Telephone and Telegraph Company stockholders' meeting. There were only about three-quarters as many stockholders then as there are now—766,000 then, and as I said in the quarterly statement, we are close to the million mark this Spring. Especially encouraging to me is the lasting interest of our stockholders in their company. Well over one-half of all those who held stock ten years ago, and over 42 per cent of those who owned shares fifteen years ago, still hold stock today. Their continuing investment, together with that of the newer stockholders, provides much of the means for rendering an improved and expanding telephone service—service on which our national strength and security increasingly depend.

During these years we have faced and successfully met many problems. Many of course are with us now, one of the most important being our responsibility in the defense effort. I wonder if we all realize how big a part the telephone plays in this whole program.

To begin with, every supplier of military equipment relies on the telephone to help him get his job done—all the way from hiring people and buying raw materials to shipping the finished product. Likewise, every branch of the Armed Forces depends on the telephone night and day. New and reactivated military camps and bases need a vast amount of telephone service and need it quickly. The telephone companies must keep in the best possible position to meet these needs, often on very short notice. The telephone system is also the nerve system of the air raid warning network, over which reports are flashed from thousands of observation posts to centers where information is analyzed and swiftly relayed to airfields and civilian defense organizations.

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May I remind you also that the responsibility of the Bell System does not consist of merely supplying a service that is conveniently available to be supplied when somebody asks for it. We have to be always *creating* what we are called on to provide. This process of creation can never stop, for the country's telephone needs are continually changing and increasing. So we must always be thinking ahead and inventing ahead and building for the future. I say "we must' advisedly, for that is what the country looks to us to do, and we are doing it.

Let me illustrate. In recent months the Armed Forces have again asked Bell Telephone Laboratories and Western Electric Company, the research and manufacturing organizations of the Bell System, to take on an increasing amount of work in developing and producing new types of military equipment. Some of this is communication equipment, some of it is electronic

apparatus that is largely based on the communications art. All of it is extremely important to the nation's defense. Also, as you already know, Western Electric, at the request of the Atomic Energy Commission, and with the help of Bell Telephone Laboratories, has for some time been operating the Commission's Sandia Laboratory at Sandia, N. M., which is concerned with military applications of atomic energy.

Now the point is that we are able to accept these tremendously important assignments because we have worked and are working unceasingly to keep the Bell System moving ahead and ready for what may come. The pre-eminence of our research and manufacturing organizations simply reflects this fact. We have had a dynamic policy and point of view. We have found and developed the people who were needed to come up with ideas and put them into action. And we have been successful in getting the money that is required to go ahead and do the right thing.

A stockholder inspects one of the exhibits on display at the annual meeting.

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To be financially sound and strong is not merely desirable—it is critically important. It follows that the Bell System should always be able to seek out what ought to be done, and then go ahead and do it. The basis of that ability is good earnings, depending in large part on adequate telephone rates.

In the last five years telephone rates have increased. As a result, earnings have recently shown improvement. But let us all be clear about certain basic facts—facts that everyone should know and understand.

First, increases in rates are only a little more than half the current annual cost of wage increases during the war and postwar periods.

Second, taxes and other expenses, in addition to wages, have also risen steeply, and the average investment for each new telephone we install is far higher than it used to be. This means that in addition to meeting higher operating costs, we have a higher average investment per telephone on which a return must be earned.

Third, the increases that have been authorized in telephone rates, together with increases requested, average less than 25 per cent of Bell System revenues. In the war and postwar years the general cost of living has gone up nearly 80 per cent. The average increase in telephone rates is less than one-third as much.

Now as to earnings. We can be thankful they have improved. But we must also recognize that they have come up from an abnormally low level, and can only be described as moderate today. In 1950 Bell System earnings were a fraction over 6 per cent on total capital. Ten years before, in 1940, they were 7 per cent.

To make a somewhat broader comparison, earnings on capital in these last three years have averaged 5.4 per cent. In the three years before the war they averaged 6.6 per cent.

That is enough to indicate that we are not making any so-called "record profits" today. It is true of course that the total dollar figures on earnings have gone up, but that is because our business has doubled in size. The important thing is the rate of return. Net operating income was less than 4.5 per cent on telephone plant in 1950 and this needs to be increased.

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This country has the most and the best telephone service in the world. That has been made possible because the telephone industry in the United States, under regulation, has generally had the freedom and the financial resources that are essential to create that kind of service.

These facts go together. They are inseparable. We are certain that the common sense of the American people will continue to recognize this. We are confident that wise regulation will continue to permit the earnings that are required to protect the savings of investors, provide opportunity for employees, and assure the rendering of the best possible telephone service to meet the nation's needs. We shall meet the challenge of the future, and do our full part, always, to advance the welfare, the strength, and the security of the United States of America.

Millionth Stockholders Visit Murray Hill

Climaxing several years of steady growth, the list of A T & T stockholders on May 15 reached a million people. Because the huge size of the list, the largest in the world, testifies better than words to the public's esteem for the Bell System, the enrollment of the millionth stockholder was marked by ceremonies in which the Laboratories had a part. On May 18 the "millionth stockholders" were entertained by Dr. Kelly at a luncheon at Murray Hill and shown the highlights of our work there.

Proud possessors of Certificate No. 1,000,000 for seven shares are the Brady Dentons, of Saginaw, Michigan. Accompanied by their two older boys, Brady, Jr., six, and John, three, the Dentons arrived in New York on May 11, had a weekend for sightseeing and Tuesday morning took their places on the platform of the Assembly Hall at 195 Broadway. Following the recorded words of Walter Hampden, "this was the vision of a man named Bell"—A T & T President Leroy Wilson briefly addressed the group of Bell System employees who had assembled for the occasion.

"Mr. and Mrs. Denton," he said, "it is people like you who are making Mr. Bell's dream come true. In putting your savings to work in the telephone business you make possible the further improvement and expansion of telephone service.

"This is the first occasion of its kind anywhere. Your Company – the American Telephone and Telegraph Company—is the first business in the world to be owned by a million

Dr. Kelly was host to the Dentons at lunch.

President Wilson signs the historic stock certificate.

people: a million people from all walks of life and from more than 19,000 communities all over the United States.

"As the millionth stockholder, you represent this wide-spread ownership here today."

Continuing, Mr. Wilson pointed out that the Bell System's growth rested on the savings of the many, because no small group of people could supply the capital required. Ownership, he said, is a creative process and to save money and put it to work is not only a right but a duty.

"You, Mr. and Mrs. Denton, of your own free will have entrusted part of your savings to us," said Mr. Wilson, "of your own free will you can withdraw from this business whenever you wish. This freedom that you enjoy gives the greatest possible impetus to our efforts. We must continually strive to hold your regard and confidence. We can only succeed if we succeed first of all in rendering the telephone service this nation needs and wants. And to that end, we must keep this business always a place of opportunity for able men and women who will render top-notch service as telephone employees."

Welcoming the newcomers to the Bell family of a million stockholders, Mr. Wilson said, "In joining with us, you have used your personal freedom to express your personal hopes and your personal faith in the future. This is the faith that animates free enterprise and gives it the vitality no other economic system has. This is the starting point for giving America the finest telephone service in the world. We pledge to you, and to all whose savings are invested in the American Telephone and Telegraph Company, our continuing utmost efforts to make and to keep this business always of the greatest possible service to this nation."

The Dentons visit Long Lines overseas switchboard.

After signing the stock certificate and presenting it to Mr. Denton, Mr. Wilson introduced Hartley J. Cansfield, Michigan Bell's manager at Saginaw. Lifting a foot-high blue bell from the table, Mr. Cansfield revealed a new, 500-type telephone dest:ned for the Denton home as a souvenir of the occasion. The surprise became a little more surprising when the phone rang and the operator asked for Mrs. Denton.

"Mrs. Denton," a woman's pleasant voice said over the loudspeaker system, "this is Ethel Barstow Howard in Pomfret, Connecticut. I called to congratulate you on your purchase of stock. I also own A T & T stock, but I'm at the other end of the million. You see, my father bought Bell stock for me 70 years ago and I'm still a member of the A T & T family."

Telephone calls followed from the Mayor and the Chief Operator at Saginaw; the ceremony was concluded by the audience singing "America".

In the free-space room at Murray Hill.

That night, at a dinner in honor of the event, Mr. Denton heard Charles E. Wilson, Director of Defense Mobilization, say of A T & T, "Such a broad base of ownership is a healthy symptom of a young and growing economy. It shows the faith of the people in our productive future, in the certainty of an ever-rising standard of living, affecting more and more of our people as it continues to ascend."

Arthur W. Page, speaking at the dinner said, "Since a corporation lives on and on, it must enlist and train good officers in endless succession. The professional manager, starting at the bottom and rising by merit, is a vital part of present American economy. And he is a trustee as well as the directors. His career is in the successful performance of the corporation's responsibilities and the training of his successors. His rewards–in money, reputation and satisfaction are roughly in accordance with that success . . .

"The character, experience and the wisdom with which these trusts are administered will be the test of their success. If they continue to deserve and have public confidence they will continue to have freedom enough to do their job well."

Wednesday was a quiet day for the Denton familly. They were guests at Long Lines Headquarters and then visited the Overseas Operating Room, and the roof-top installation of micro-wave antennas. On the following day they visited the Stock Exchange, where Mrs. Denton broke all precedents by purchasing a share of stock–A T & T, of course–right on the trading floor.

Friday was the windup day of the Denton's week in New York and it turned out to be a pretty busy one. By 10 A.M. they were out at Western Electric's Kearny plant. Mrs. Denton was fascinated by the machine which color-wrapped the individual wires, but the huge cable stranding machines and presses were more of a man's show and the "men" ate it up.

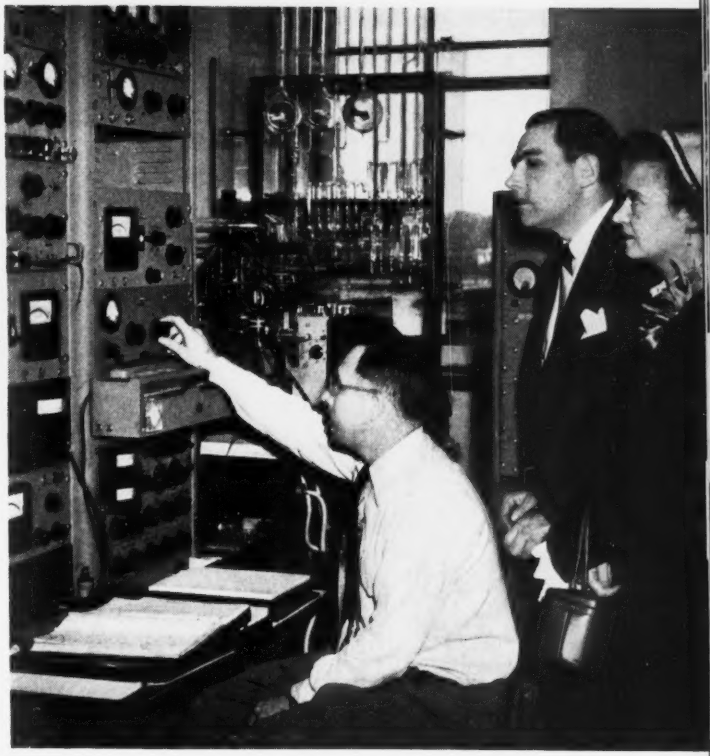
From Kearny the party drove to Murray Hill, where they were welcomed by Dr. Kelly and taken to lunch with some of our executives. In a tour, they saw the electronics and metallurgical laboratories, the wood preservation studies, the free-space room, and the exhibits on the concourse.

Before the Dentons left, Dr. Kelly presented them with souvenirs of their Laboratories visit –to Mrs. Denton, a pair a synthetic quartz crystals which had been fashioned into earrings, and to Mr. Denton, a cigarette box, in the top of which a number of small telephone components were embedded.

Dr. Kelly welcomes our guests at Murray Hill.

John Leutritz explains why and how the Bell System uses preservatives.

A. R. Brooks, center, answers questions about the crystal and semiconductor exhibit on the Concourse.



The Dentons watch F. J. Koch making studies of the action of electrically charged atoms which strike metals under controlled conditions.

Back home in Saginaw, the Dentons will always take an interest in telephone construction work.

Recent Transferees Meet, Dine at Murray Hill

S. B. Cousins, H. L. Falkenstein and M. J. Kelly

So that the 175 men from Associated Companies who have recently transferred to the Laboratories might become better acquainted with Laboratories executives and with each other, they gathered at dinner on May 7 at Murray Hill. Immediately following the dinner, S. B. Cousins welcomed the men and then introduced M. J. Kelly who discussed the military program under way, emphasizing the part that the Laboratories is playing in strengthening the defenses of our country. Dr. Kelly spoke of how enthusiastically the Associated Company men were entering into the program, relating the many fine reports they were getting from the supervisors.

The evening was concluded with an inspection trip which covered the electronics laboratory, the mathematical computer, the instrumentation laboratories, metallurgy, auditorium, free-space room, outside plant, telephone instruments, and the special exhibits that have been placed in the concourse.

Above—Products of the Outside Plant Development Department are displayed in one of the exhibits on the concourse.

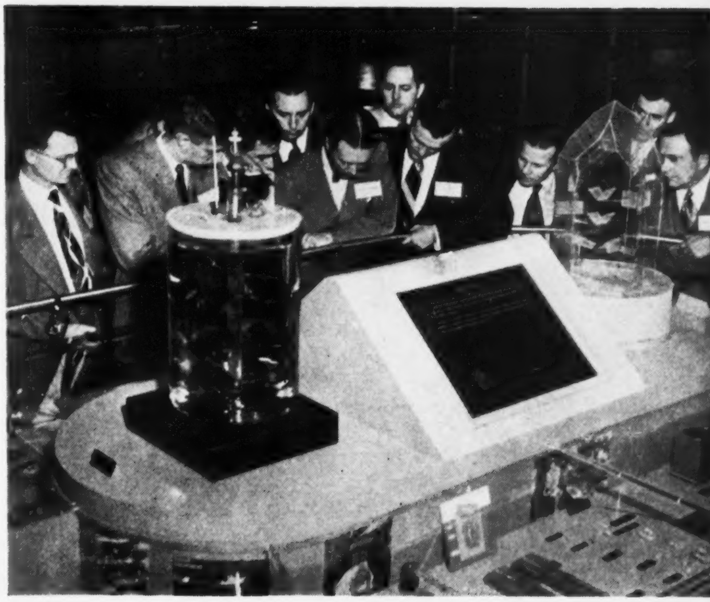
Above, right—The free-space room in the acoustics laboratory.

Right—The transferees examine the exhibit of crystals and semiconductors in the concourse.

Below—E. I. Green explains the operation of the mathematical computer.

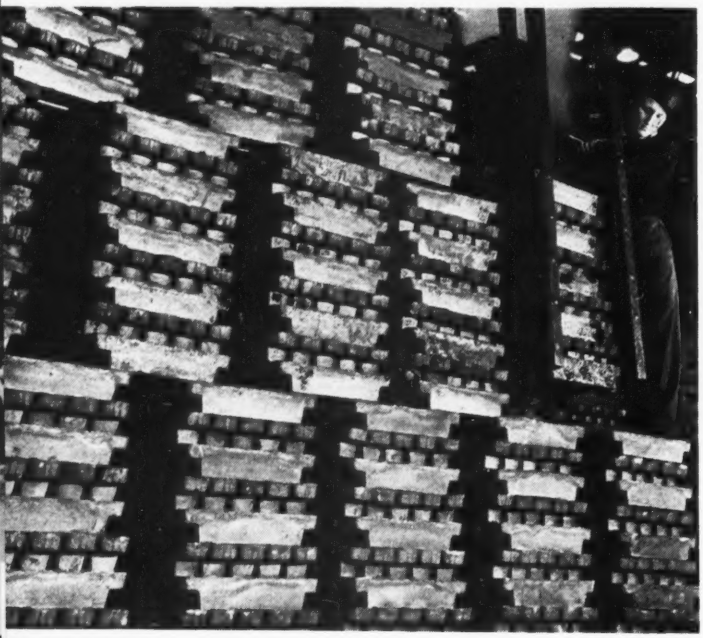
Below, right—M. W. Bowker describes and demonstrates trouble detection in cables.

At the bottom of the opposite page, W. H. Doherty discusses the latest electronic developments (left) and the transferees view the N1 carrier display.



Conservation and Substitute Materials

In the fifth lecture of the current series of out-of-hour informative lectures given at West Street April 16 and Murray Hill April 18, J. R. Townsend said that national planning in the present emergency designates that certain materials in critical supply must be directed toward three channels: a civilian economy, national defense, and stock-piling. While the economic use of materials is always an engineering and design problem, it is especially important at the present time to use materials in the most effective way as to selection and quantities employed, and to use substitutes for critical materials whenever this can be done without degrading the product to a dangerous point. Experience in World War II showed that many new or alternate materials were so effective that



"As much as 115,000 tons of lead have been used annually for cable sheath."

they were retained because of improved performance, economy of investment, or both.

In his lecture, Mr. Townsend reviewed the progress of our conservation and substitution program, using typical examples of the utilization of substitutes. For example, the use of copper clad steel wire has been extended; reduction of some wire in subscriber cable from 22 to 24 gauge is under consideration. At scheduled rates of production and if all conservation is realized, about four thousand tons of copper will be conserved. This is about 5 per cent of the present annual consumption by Western Electric.

Use of lead in the Bell System is another item in which conservation measures are being taken. As much as 115,000 tons of lead have been used annually for cable sheath, but the introduction of the composite polyethylene-aluminum sheath (known as Alpeth) has provided some conservation of lead. Unfortunately, aluminum is also a strategic metal, and efforts to reduce aluminum consumption have been made by using a thinner aluminum sheath.

Zinc, tin, nickel, cobalt, and some precious metals are also important and in short supply. Tin, especially, is a critical metal because the majority comes from the East Indies. Reduction of the tin content in solder has been accomplished as far as seems permissible without increasing the probability of poor solder connections. Another conservation measure is electroplating tin on copper wire rather than the older hot dip process. Electroplating not only saves two-thirds of the tin, but provides a more uniform coating. Solderability of the wire is not degraded in the least by the new method.

Nickel, used in nickel silver contact springs and in magnetic materials, is another important metal. Research has shown that the reduction in the amount of nickel, accompanied by an increase in zinc, can be made without impairment of the nickel silver alloys. Although zinc is also a strategic material, nickel is less abundant than zinc and, therefore, the substitution is in the right direction.

In magnetic materials, nickel is important in the Permalloys used for obtaining high permeabilities and low core losses. Substitution of hydrogen treated iron and silicon-iron alloys has been possible, where some degradation is permissible.

In nonmetallic fields, mica and quartz are found on all lists of strategic materials. To select mica having the electrical quality needed, the Laboratories, at the request of the War Production Board, has developed an electrical test method that replaces the older method of selecting mica by appearance. The new test procedure has shown that much mica that would be rejected by the appearance scale would make satisfactory capacitors.

Natural quartz crystals, used in wire and radio communication systems for controlling frequency, come principally from Brazil. Artificial growing of quartz crystals has been under development for a number of years, and more work is being carried on with the U. S. Signal Corps.

Synthetic rubber has a well known place for

"... Neoprene makes an entirely satisfactory tough and long life jacket for drop wire ..." C. C. Lawson (left) examines a roll of Neoprene drop wire with C. B. Clotworthy (W. E.) and G. N. Vacca.

itself in technology. Some of the synthetic rubbers are superior to natural rubber for certain uses; for example, neoprene makes an entirely satisfactory tough and long life jacket for drop wire and telephone cords. A particular virtue of natural rubber is its resistance to low temperatures; hence, the use of synthetic rubber releases natural rubber for use by the Armed Forces.

Telephone apparatus taken individually consists of a great number of small units. In the aggregate, however, this apparatus involves large amounts of material as shown by the anticipated 1951 consumption of 1600 tons of aluminum, 72,000 tons of copper, and 64,000 tons of iron and steel products. To make the most efficient use of this vast quantity of material, an active and experienced team of engineers is required to study, investigate, and test alternate materials and designs. Experience has shown that the end product may be improved rather than degraded, and many substitutions remain in use after the emergency has past.

Glassmakers See Murray Hill

Among recent visitors at the Murray Hill Laboratory were twenty-two research and development supervisors of the Owens-Illinois Glass Company. These supervisors annually hold a convention at one of the several company plants, and in this instance the convention headquarters was Bridgeton, N. J. In the course of this year's meetings, visits were made to various plants in the Eastern territory to learn about other organizations.

At Bell Laboratories, some of the group were more interested in plant operation problems, while others had queries on the research organization and tasks. The gathering was addressed by W. H. Martin, J. B. Fisk, H. J. Wallis and M. L. Wilson on the various aspects of Laboratories' work, and a tour highlighting some of the points in the talks, was conducted by H. B. Ely, A. J. Akehurst and A. R. Brooks.

Communication Development Training Program

Students and instructors of the Transmission Systems Course of the Communication Development Training Program recently went on an inspection trip of Long Lines facilities of A T & T. The trip included the Long Lines terminal in New York City, the unattended K-system repeater station at Highland Park, New Jersey, and the attended K- and L-system repeater station at Princeton. Conductors for the trip were course instructors K. G. VanWynen and D. K. Gannett. After the day of plant inspection, a dinner was held at the historic Nassau Tavern at Princeton.

The trip was arranged through the courtesy of A. H. Swaikert and F. A. Cowan of A T & T Long Lines, and was conducted at Princeton by John Stalker of General Plant, A T & T.

A T & T Guide N. A. Bergstrom explaining the testing procedures for maintenance and operation of the L carrier system and the radio relay at Martinsville, N. J. Left to right, M. O. Fichter, a special student, N. Ehrlich, A. R. Nolan, M. Chruney (partially hidden), N. B. Rowe, E. G. Walsh, and Mr. Bergstrom. M. H. Nothman, one of the students, took the picture.

Lab Developments Shown to Plant Managers

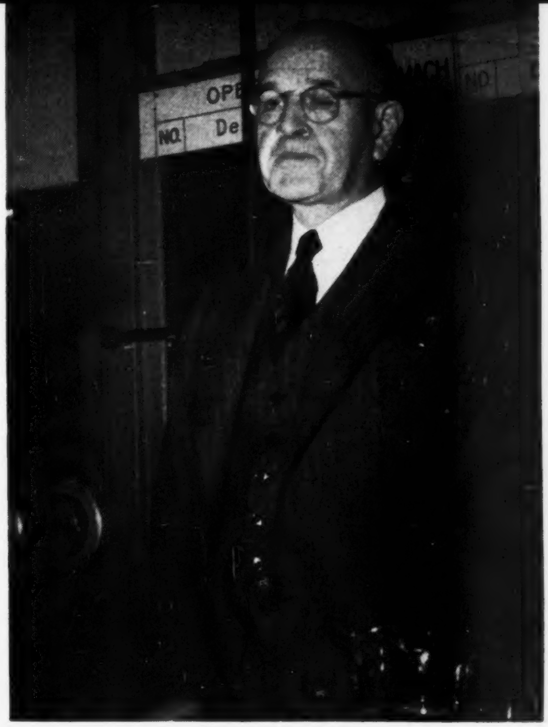
At the Bell System General Plant Managers' conference, held during the period of April 24 to April 27 at the Westchester Country Club, several recent Laboratories' developments in outside plant were demonstrated. R. J. Nossaman participated in the program on the morning of April 25 with a talk on the prelashing of aerial cable. The afternoon of this same day was devoted to a series of demonstrations of outside plant construction and maintenance interest. These demonstrations included prelashing under actual service conditions by construction forces of the Bronx-Westchester Area of the New York Telephone Company, line insulation testing, breakdown methods of cable conductor fault location, and rapid methods of cable repair by A T & T, Upstate New York and Ohio Bell representatives, and the halide leak detector for locating sheath faults in aerial cable. The latter demonstration was given by M. W. Bowker of the Laboratories Outside Plant Development Department and E. R. Albrecht of the Long Lines Department. Other demonstrations of the afternoon included latest designs of installation, construction and maintenance vehicles and of power tool equipped vehicles for digging pole holes and setting poles and anchors. Other Laboratories men at the conference were A. B. Clark, W. H. Martin, M. B. McDavitt and F. J. Singer.

Society of Motion Picture and Television Engineers

As a part of the 69th Semi-Annual Convention of the Society of Motion Picture and Television Engineers held in New York April 30-May 4, one of the television sessions was held at the Murray Hill Laboratories.

After assembling in the Arnold Auditorium, the group was welcomed by R. Bown. M. W. Baldwin, Jr., then presented a paper entitled *Subjective Sharpness of Additive Color Pictures.* A. G. Jensen described a tour through the Laboratories, this being followed by a visit of a portion of the group to the free-space room, crystal growing activities and special demonstrations in the Television Research Department. These consisted of a demonstration by M. W. Baldwin of the three-color optical projector, a demonstration by W. Herriott of the electronic lens bench developed by him and described some time ago in his paper published in the *Journal of the Optical Society;* a talk by A. G. Jensen and a demonstration by R. E. Graham and C. F. Mattke of an experimental model of a continuous motion picture projector developed for use as a television film scanner. The remaining part of the group then heard P. Mertz give a paper on *Data on Random Noise Requirements for Theater Television.* Another paper entitled *The Conversion of Electrical Signals into Visual Information* by D. T. Wilber, Du Mont Laboratories, followed.

M. W. Bowker, back to camera, demonstrates the halide leak detector to an attentive audience.



W. H. MARTIN

W. H. Martin Discusses Designs for Manufacture

On April 13, at Harvard University's Graduate School of Business Administration, W. H. Martin participated in a conference which was sponsored by the University and the Society of Industrial Designers. The purpose of the conference was to discuss the relations between business organizations and industrial designers, in the development of designs for manufacture.

Mr. Martin explained how the Laboratories works with the operating telephone companies and the Western Electric Company in developing designs for manufacture and use. He stressed our aim of "design for service" to get maximum ratio of service value to annual charge, including operation and maintenance.

The development of the 500-type telephone set was used to illustrate this integration of the development of the design with the requirements of manufacture and those of use, and also simultaneously the integration of the design with the ideas of form and appearance. For this latter phase of design the Laboratories have for many years retained Henry Dreyfuss who was associated with Mr. Martin in this conference.

ECA Visitors from the United Kingdom at Murray Hill

One of the visiting foreign groups brought to the United States recently under the Economic Cooperation Administration technical assistance program was from the United Kingdom. This group, a combined Universities-Industry Education team, visited Murray Hill April 24 in the course of a six-week tour in the United States. During the morning, talks on several Bell System and Laboratories activities were given in Arnold Auditorium; D. S. Bridgman of A T & T spoke on *Training and Personnel of the Bell System;* F. D. Leamer, *Technical Education Items on Personnel,* and R. K. Honaman, *Publication Items.* A visit to the free-space room followed.

After lunch, the groups made a tour of the Murray Hill laboratories. At the conclusion of the tour, they returned to the Auditorium, where M. J. Kelly spoke on *Education.*

The ECA United Kingdom Universities-Industry Team that visited the Murray Hill Laboratories during a six-week tour of the United States.

Experts with Circle and Line

The only but not lonely male figure in the picture below is that of engineering draftsman R. S. Boughrum. Occasion was the graduation of nineteen girls from a seven-week course which he conducted in elementary drafting. The graduates—all but three are newcomers to the Laboratories—will help out in drafting departments hard pressed by rising tempo of military work. Six of the girls will be stationed at Whippany, the others in Apparatus and Systems drafting at Murray Hill. Appearing in the picture (taken by W. S. Suydam) are: Top Row, left to right, Ann Wachenfeld, Lois Wallerstein, Frances Foster, Noralyn Schulte, Audrey Muller, Frances Kunz, Virginia Cooper. Middle Row, left to right, Barbara Hall, Lois Nunn, Mary Jane Regan, Naoma Fry, Pamela Scull. Bottom Row, left to right, Margaret Bell, Dorothy Zahn, Jean File, Dorothy Maguire. Not pictured but also graduating were Gertrude Gonroski, Anne O'Donnell, Phyllis Jackson.

International Radio Conferences

The Sixth Plenary Assembly of the International Radio Consultative Committee (C.C.I.R.) will meet in Geneva, Switzerland, from June 5 to July 8, to consider various technical questions. Items of interest to the Bell System include studies of band width and channel separation, standards of performance for radio apparatus and systems, radio noise and propagation studies; and reduction of interference to television receivers from radiations.

The United States delegation will include C. C. Taylor of the Laboratories and E. W. Bemis of O & E. Mr. Bemis is Chairman of the U. S. Preparatory Committee concerned with questions relating to complete radio systems. On their way home, Messrs. Taylor and Bemis will visit various laboratories on the Continent and in England.

Whippany Men's Glee Club Entertains at the State Hospital

The Men's Glee Club of the Whippany Laboratories volunteered their services to the Greystone Park State Hospital where they gave a concert on April 10. During the evening's entertainment the thirty members of the chorus gave a full program during intermission at the regular evening dance of patients in the dormitory recreation hall. The quartet consisting of W. L. Shaffer, R. O. Sinclair, W. E. Ingerson and B. J. Thomas also sang. At the request of the Institution, the Glee Club hopes to give more than one concert a year for the patients.

L. C. Mueller
40 years

E. D. Mead
35 years

O. S. Markuson
40 years

June Service Anniversaries of Members of the Laboratories

40 years

O. S. Markuson
L. C. Mueller

35 years

J. A. Coy
E. D. Mead
V. F. Miller
G. H. Somerville
W. Stumpf

30 years

O. H. Coolidge
R. A. Deller
H. W. Dudley
F. F. Farnsworth
J. W. Gibson
M. C. Goddard
E. I. Green
R. O. Hagenbuck
S. J. Harazim
Eleanor Iasillo
Ruth Jennings
F. K. Low
W. P. Mason
C. H. McCandless
C. H. Meissner
R. L. Pentland
J. C. Rile
E. M. Smith
I. G. Wilson
H. O. Wright
L. A. Yost
J. Zoller

25 years

G. M. Bouton
S. O. Ekstrand
H. C. Foreman
W. L. Gaines
H. L. B. Gould
H. A. Henning
K. M. Hicks
F. A. Hinshaw
A. E. Kerwien
L. E. Krebs
A. E. Leitert
W. J. Locke
P. R. Menzel
L. R. Montfort
C. N. Nebel
Margaret Packer
M. R. Purvis
S. A. Schelkunoff
E. B. Stallman
H. G. Thourot
K. M. Weeks
N. S. Whitehead

20 years

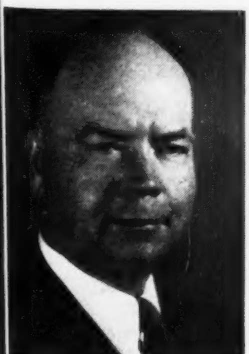
A. L. Hopper
J. F. Muller

15 years

R. Blaschke
F. J. Herr
J. B. Howard
F. C. Kozak
J. B. Maggio
Grace Markthaler
C. H. Matthews
R. C. Nance
H. E. Noweck
Jane Otto
Catherine Potter
Constance Roke
E. F. Schneller
C. R. Schramm
F. J. Schwetje
F. E. Stehlik
V. T. Wallder

10 years

W. B. Bachmann
G. G. Bailey
R. S. Beattie
G. Chabra
O. P. Clark
H. W. Collier
J. H. Devereaux, Jr.
W. M. Ehler
H. O. Emmons
P. W. Foy
R. C. Fremon
J. W. Geils
Mary Getchius
G. W. Gotfredsen
D. W. Graham
W. C. Heaton
H. H. Hoffman
Jean Forst
D. C. Koehler
J. F. Laidig
J. Lee
J. Leighton
E. A. Lichtenberger
C. A. Liscum
P. Mallery
R. G. McCoy
H. C. Meier
Betty Mocksfield
R. Nelsen
T. J. O'Connor
B. Ostendorf, Jr.
H. L. Pappler
D. H. Schell
W. R. Schleicher
K. L. Schmitz
F. G. Scudner, Jr.
J. L. Smith
H. M. Straube
R. L. Trent
S. N. Turner
F. C. Wanits
H. J. Wirth, Jr.
D. H. Wright



G. H. Somerville
35 years

J. A. Coy
35 years

V. F. Miller
35 years

W. Stumpf
35 years

Frank B. Jewett Chapter

New York Council

More than 250 Pioneers and guests including 12 Life Members attended a get-together party at West Street on April 18. Frank Meyer was Master of Ceremonies for the evening and the entertainment was provided by the West Street Chorus. The dinner was held in the restaurant and was followed by sound motion pictures at 7:00 P.M. in the auditorium. S. B. Cousins gave a short talk on *The Place of Pioneers In The Bell System*. Following the entertainment punch and cookies were served.

Above—members of the West Street Chorus who entertained at dinner in the restaurant during the Pioneer get-together. Left—Mr. and Mrs. A. B. Clark and Mr. and Mrs. M. B. McDavitt. Left, below—General view of the restaurant during the Pioneer get-together. Below—In the lounge Peggy Malloy, second from left, of the restaurant watches as Laura Tinelli and May Ressler serve punch.

Telephone Pioneers of America

New Jersey Council

The New Jersey Council completed the 1950-51 season of "regional get-togethers" with a dinner-dance held at Far Hills Inn on Friday, April 27. This affair was eminently successful, as have been all of those which preceded it throughout the season. About 200 Pioneers and guests attended, enjoying a fine dinner accompanied by excellent entertainment. Best of all, the spirit of Pioneer fellowship was distinctly evident throughout the evening.

Professional entertainment for the evening was provided by the Barnett Trio, a musical family; Russel Bent, magician; Joan Brandon, tap stylist; Evelyn Geetlein, songstress; and Terry Rillo, accordionist.

This party brought the total attendance to 2424 participants in the New Jersey Council's six events for the 1950-51 season. The photographs on this page show a few high-lights of the dinner-dance.

RETIREMENTS

C. D. Lindridge

R. P. Ashbaugh

John Bachor

Recent retirements from the Laboratories include C. D. Lindridge with 44 years of service; R. P. Ashbaugh, 40 years; John Bachor, 38 years; Rodger Clifford, 37 years; and E. W. Kane, 29 years.

Robert Paul Ashbaugh

Born and raised on a farm in southern Ohio, Paul Ashbaugh, after graduation from the village high school, in turn tried teaching in country schools, wholesale dry goods clerk and farming. Not satisfied with any of these occupations as a career, he entered the nearby Ohio University and graduated in Electrical Engineering in 1910. He entered the Bell System through the Student Course at the Western Electric Company at Hawthorne in January, 1911. After a year as a student and another year in development engineering for loading coils and general apparatus he joined G. A. Anderegg's group of cable engineers at Hawthorne and has lived, breathed and talked telephone cables ever since. His first assignment was to nurse the Boston-Washington quadded cable through the cable shops, watching every operation to assure satisfactory manufacture. From there he went on to all phases of design and development of telephone cables.

It is a tradition that the cable development engineers live in the Western Electric factories and Mr. Ashbaugh has never worked elsewhere. He was resident head of the group at Hawthorne from 1929 until 1938 and in charge of exchange area cable development at Kearny since 1938. In 1943 the entire specification and current engineering group was added. As an interlude he spent two years in Japan from 1922 to 1924 with the International Western Electric Company, first as consultant for the installation of the first quadded cables placed in Japan and later as adviser to the Sumitomo Cable Works on problems of toll cable design.

Mr. Ashbaugh's work has been most closely associated with exchange type cables, cable sheaths and cable sheath protections. He has had a prominent part in all the following developments. From 1913 to 1920 emphasis was on fine wire cables to get more circuits into a cable sheath. This period saw the 22 gauge cable increased in size from 606 pairs to 909 pairs and the beginnings of 24 gauge cables. The 1920's brought cable sizes up to 1212 pairs 24 gauge and the development of 26 gauge cables in sizes up to 1818 pairs. In this period his work was also largely responsible for the development of pulp insulation and unit type cables. In the 1930's cable sizes were increased to 1515 pairs of 24 gauge and 2121 pairs of 26 gauge. Corrosion protection and jute protection were developed and beginnings were made on composite sheath. In the last decade his group has developed pulp insulation for 19 gauge conductors and since World War II Alpeth and Stalpeth composite cable sheath.

The Ashbaugh's have lived in Westfield for the past 12 years but they expect to make their future home in the lake region of Florida where golf is available, fish can be caught, and vegetables and flowers can be grown. They have one son who, with his wife and three children, live in Venezuela and is associated with the Creole Petroleum Corporation.

Charles D. Lindridge

Because he was deeply interested in the problem of a telephone repeater, Mr. Lindridge passed up the family business of selling musical instruments, and left England in 1906. He got a job in the plant department of New York Telephone Company and in his spare time worked on a repeater. He remembers well seeing, in 1907, Lee DeForest demonstrate his "audion." Transferring in that year to Providence, Mr. Lindridge began making experimental tubes and in 1912 published an article on repeaters in which he noted the phenomenon of feedback.

During World War I Mr. Lindridge served

in the Signal Corps and was commissioned Second Lieutenant. He entered the Laboratories in 1919 and worked nearly a year on repeater development. Following this, he was assigned to carrier telephony, then in the early stages of development. From 1923 to 1925 he was engaged on equipment development for toll switchboards, and then joined the group which developed the equipment for carrier systems. He has had a part in the development of radio control terminals, of the Types C, J, N, and O systems, and of carrier pilot channel equipment. During World War II he worked on spiral-four carrier systems, Sonar, and on an important development which is still classified.

In retirement, Mr. Lindridge sees a chance to combine two of his interests, by developing electronic musical instruments. He and his wife expect to remain in their home in Montclair.

John Bachor

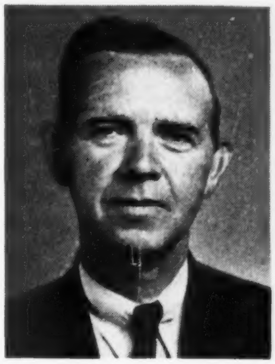
If you have been eating in the service dining room at West Street, the expert in the kitchen who made your soup and later filled your plate was John Bachor. Born in the little town of Malatska near Bratislava, Czechoslovakia, John learned the tailoring business but soon after he came to this country in 1906 he became a counterman. In 1912 he took a part-time job in the West Street restaurant, making sandwiches and then serving luncheons. Soon he was given a full-time job as a cook, continuing as "office waiter" until about 1940, when he went over to the serving job.

Married, with a daughter at home, a son and grandson not far away, John has no desire to move away from Great Neck. After a few weeks or maybe months he expects to put on the cap and apron again, and resume his career.

Rodger Clifford

As a young farm worker in England, Rodger Clifford made plans to go to Australia with one of his pals, but when his friend changed his mind, Rodger gave up the idea. Then a sister returned from America to the old home country of Ireland and persuaded Rodger to go back to America with her. This was in 1913; and about six months later he was working at the Laboratories as a night cleaner. Two years later he became a porter on the twelfth floor, and subsequently was made a uniformed elevator operator and guard. He became well known to many Laboratories people as the guard who accompanied the paymaster on his weekly trips through the West Street building and at Graybar.

Although he has lived in a number of places in Manhattan and the Bronx, Mr. Clifford prefers his present home in the Greenpoint section of Brooklyn, where he has lived for twenty years. In his younger days, he played a lot of handball; now he says he is content to watch others play. In retirement he plans to take life easy for awhile, and perhaps later find some work similar to his job here. With his wife, four sons, one daughter, and two grandchildren, he should have plenty of company to keep him busy. One son, Edward, is employed in our Mailing Department.



Rodger Clifford

E. W. Kane

Edward W. Kane

In World War I, Mr. Kane was an artillery officer, so it was a happy coincidence that he had a chance to help the artillery of World War II by producing potentiometers for fire control. When he came back from his first war, Mr. Kane finished at Princeton and got his B.S. degree "as of" 1918; then soon went to work for Long Lines on cable engineering. In 1924 he transferred to the D & R, working on outside wire and cable terminals. With his group he came to the Laboratories in 1934 and soon was assigned to the study of base metal contacts.

By 1938 shortages began to be a problem, and Mr. Kane became engaged in the application of substitute materials. When the M-9 Gun Director* program was started, he joined the group which developed the potentiometers which simulated mathematical functions. A year ago, when this type of work was moved to another location, Mr. Kane remained at West Street to work on glass-enclosed relays of the dry-reed type.

Long interested in production of accurate parts, Mr. Kane will take up that kind of work in a new jet engine plant of the Utica Drop Forge and Tool Company. The location is a happy one for the Kanes, for they have a home in the Adirondacks, and Mr. Kane can go hunting every weekend in the season. But he is sorry to leave Ossining, where he has been active in civic work and a member of the Draft Board.

*Record, *January*, 1944, *page* 225.

Leaders and workers opened the 1951 campaign of the Greater New York Fund with a meeting in the West Street Auditorium on May 14. M. J. Kelly told of the purposes and goal of the campaign and the role of the Fund in providing for 423 welfare organizations in New York City. Pictured are the moving spirits in the drive: J. A. St. Clair, Laboratories chairman for the campaign; S. B. Cousins; J. C. Kennelty, vice-chairman of the Club; Mrs. C. A. Smith, assistant secretary of the Club; M. J. Kelly; R. H. Wilson, president of Bell Laboratories Club; D. D. Haggerty, executive secretary of the Club.

A.I.E.E. Fellows

During the fiscal year June 1, 1950, to June 1, 1951, eight Laboratories' engineers have been honored by the A.I.E.E. by being made Fellows of the Institute. These are: P. W. Blye, A. J. Busch, T. C. Fry, R. V. L. Hartley (retired), A. D. Knowlton, M. B. McDavitt, H. Nyquist, and J. D. Tebo.

Changes in Organization

E. J. Quinn has been appointed Station Systems Development Engineer, reporting to A. F. Bennett. In this work, Mr. Quinn's fifteen years in telephone engineering with Bell of Pennsylvania will prove as valuable as it has been in his former job of analyzing special equipment orders from telephone companies. Mr. Quinn joined us in 1942 as a World War II transferee. He now succeeds C. W. Halligan whose time is fully occupied in a war job as noted in the RECORD for March.

News Notes

O. E. BUCKLEY, a member of the Advisory Council of the Electrical Engineering Department at Princeton, attended the annual meeting on May 5. Among Council members at this meeting were P. B. FINDLEY; and a former member of the Laboratories, E. U. Condon, now director of the National Bureau of Standards.

A CONFERENCE on automatic computing machinery was held at Wayne University in Detroit on March 27 and 28, and was attended by B. D. HOLBROOK, A. E. JOEL, and E. G. ANDREWS of these Laboratories. During the conference a paper by R. S. GRAHAM and E. G. ANDREWS discussing problems solved on the Bell Telephone Laboratories model 6 computer was presented by Mr. Andrews.

R. I. WILKINSON and A. E. RITCHIE attended a conference at the Franklin Institute with representatives of the Institute and of the Air Navigation Development Board to discuss the problems of air traffic simulation involved in the study and development of air traffic control systems. Many of the problems involved are closely related to those of telephone traffic, and Messrs. Wilkinson and Ritchie told of their experience with such problems and also with the traffic study machine at the Laboratories used in studies of No. 5 crossbar traffic.

W. BENNETT, A. BURKETT, and L. O. O'BRIEN, together with C. W. Anderson of the A T & T and several engineers of the Southwestern Bell

Telephone Company recently visited two new installations of the 356-A community dial offices at Gibson and Locust Grove, Georgia. This new dial office is a "packaged" step-by-step system for from 40 to 300 lines arranged so that the maximum amount of assembling, wiring, and cabling can be accomplished in the shop.

In connection with preparations for the proposed test this fall of subscriber dialing of long distance calls, a study was recently carried out of the transmission of toll dialing signals over the N1 carrier system, which now is used between the Second Avenue tandem office in New York City and Hempstead, Long Island. O. H. Williford and R. Gryb placed calls at Englewood, while R. W. Ulmer at the Second Avenue tandem office, and A. Ludwig at Hempstead studied the results with recording apparatus. Also in connection with problems of subscriber dialing of long distance calls, A. A. Burgess and G. Riggs visited the Newark offices of the New Jersey Bell Telephone Company.

Shortly after the development of the No. 5 crossbar system, a committee representing the Laboratories and the Western Electric Company was formed to coordinate changes in the system with the Western Electric production at Hawthorne. This is a new method of handling changes, and is proving very valuable. Known as the No. 5 Change Introduction Committee, the committee includes three representatives of the Laboratories, W. E. Grutzner, who is secretary of the committee, K. M. Fetzer, and L. J. Scott, and four representatives of the Western Electric Company. The committee meets alternately at the Laboratories and at Hawthorne. The meeting last month was at Hawthorne, and R. E. Hersey and F. P. Wight accompanied the three committee members.

Holes and electrons in germanium—a subject of prime importance in Transistor research—was the subject of a talk by W. Shockley before a session over which he also presided at the Pittsburgh meeting of the American Physical Society. Also present were W. H. Brattain, G. L. Pearson, P. W. Anderson, J. K. Galt, G. H. Wannier, K. G. McKay, H. D. Hagstrum, and W. T. Read.

Imperfections in crystal lattices—as few as one in a million—can explain why a solid does not recover its shape when deformed. W. T. Read discussed this in his paper *On the Geometry of Dislocations* at the University of Chicago, and at Rice Institute in Houston, Texas, under the heading of *Dislocations in Metals*. Why metals conduct so well when they are very cold was discussed by J. Bardeen at Ohio State University, the University of Illinois, and the Low-Temperature Conference at the Bureau of Standards in Washington.

J. A. Morton has been honored by Wayne University "for distinguished service and accomplishment in science." He was presented with a University Alumni Award at the Wayne Alumni reunion banquet in Detroit on May 5.

J. J. Harley, G. M. Eberhardt and John R. Hefele contributed notably to the Gala Night program of the Metropolitan Motion Picture Club at Hunter Playhouse on April 27 and 28. Club members worked with Mr. Harley at his

Called to Active Duty

A. J. Wahl

During April, one more Laboratories person was called to active duty, while another completed his tour of duty and has returned.

ARTHUR J. WAHL, a member of the technical staff, who was engaged in magnetic studies in the Transmission Development Department, was recalled to active duty in the Air Force. He had been with us since July, 1950, and, as a reservist, returns to the service as a Major.

CLIFTON K. DALE, a senior assembler and wireman, has completed his service in the Navy. He was recalled to duty as a Chief Electrician's Mate in August, 1950, and returned to the Laboratories in April, 1951.

Chapter-Wide Family Picnic

The Frank B. Jewett Chapter No. 54 of the Telephone Pioneers of America will hold its annual Chapter-Wide Family Picnic again this year at Farcher's Grove, Union, New Jersey, on Saturday, June 9. There will be dancing and music from noon until night, and the usual racing and ponies for the children. Don't forget to reserve the date—June 9.

A baseball game at Whippany–showing Thomas Moreland, up; Thomas O'Connor, pitcher; Robert Crawford, catching; and Umpire Frank Gruber.

home in Summit for two months and as a result, in collaboration with Mr. Eberhardt who is a tape-recording fancier, they had devised their own extra-slick way of getting music and commentary on a tape, the recording being synchronized by a new method. The result was an especially successful evening at the Club.

L. F. Koerner spoke at a meeting of the Tri-county Radio Association on April 21 at the Plainfield Red Cross Headquarters. His talk covered the manufacture of crystals and their application in oscillator circuits. The Association's radio emergency equipment is located in the Red Cross Headquarters.

While helping the U. S. Signal Corps in establishing communications* for the Armed Forces in Europe, Lee Glezen frequently worked with Brigadier L. H. Harris, then Chief of the Telecommunications section of SHAEF. Recently Brigadier Harris has published a book† on his wartime experiences in which he mentions one of the occasions when they met at Kaiserlautern, Germany, where Mr. Glezen was assisting the Signal Corps in establishing communications forward into Germany using Laboratories' designed CF4 and CF5 carrier systems. Brigadier Harris is now head of the Post Office Research Laboratory at Dollis Hill, near London. He expects to visit the United States and the Laboratories this summer.

Recent appointments again testify to the active participation by Laboratories members in scientific societies. M. D. Rigterink who was elected a Fellow of the American Ceramic Society takes over chairmanship of its New York Metropolitan Section. K. G. Compton has been appointed chairman of the Management Committee of the Gordon Research Conferences of the American Association for the Advancement of Science.

W. P. Mason is on the Nominating Committee of the American Institute of Physics and J. A. Hornbeck, on the Executive Committee of the Society's Division of Electron Physics. J. B. Johnson, vice chairman of this Executive Committee, heads the committee for arranging the Washington meetings of the Division next Fall. The House Committee of the North Jersey Section of the American Chemical Society is to be headed by V. T. Wallder. G. T. Kohman will serve on the A.I.E.E. Basic Sciences Subcommittee on Dielectrics.

Diamonds and the effect of inhomogeneities on their electrical properties was the subject of a talk by A. J. Ahearn and K. G. McKay at the M.I.T. Electronics Conference. J. A. Becker talked on *Techniques in the Production of Ultra-High Vacua* and G. H. Wannier on *Computation of Ionic Drift Velocity in High Fields.* Also present at the conference were J. J. Lander, J. A. Hornbeck, A. H. White and J. B. Johnson. Mr. Johnson, who was recently made a Fellow of the I.R.E., stopped off at the Physics Colloquium of Brown University to speak on the *Origin of Bombardment–Enhanced Thermionic Emission.*

G. H. Wannier who is a native of Switzerland has sailed to lecture for three months on theoretical physics in the University of Geneva.

Tantalum electrolytic capacitors, which are remarkable for the capacitance they can pack into small size and which were introduced into the telephone plant in the new type-N Carrier, were the subject of a recent visit by A. J. Christopher, M. Whitehead and B. M. Bowman to the General Electric Company at Pittsfield, and the Fansteel Metallurgical Corporation, Chicago. These companies are to manufacture tantalum capacitors for Government

*Record, *March*, 1946, *page* 121.

†"Signal Venture," published by Gale and Polden, Aldershot.

ssing the first ball of the season, H. C. Atkinson, New York and Whippany Area Manager, opens the baseball ason at the Whippany laboratory.

apparatus to be manufactured by the Western. With C. C. HOUTZ, Messrs. Christopher and Whitehead attended the Electrochemical Society Convention in Washington for the presentation of several papers on electrolytic capacitors, one of which was on the tantalum type written by R. L. TAYLOR and Mr. Whitehead.

FERRITES, latest arrival in the field of practical magnetics, will play an important part in the new type-O short-haul open-wire carrier system where their high permeability and low loss makes possible transformer and coil cores attractively small in both space and cost. C. D. OWENS and F. J. SCHNETTLER visited Hawthorne where Western Electric engineers are setting up for the full-scale production of ferrite cores.

WITH THE ULTIMATE GOAL of realizing still better magnetic materials Solid State physicists are actively exploring magnetic theory. At the Pittsburgh meeting of the American Physical Society C. KITTEL gave a paper on *Antiferromagnetism and the Néel Theory of the Ferrites* and H. J. WILLIAMS, on *Observation of Magnetic Domains by the Kerr Effect*. R. M. BOZORTH spoke on *Magnetic Domain Patterns and Their Interpretation* before the Physics Colloquium of the University of California at Berkeley.

ELECTRON METALLOGRAPHY, a technique that metallurgists employ to detect structural details beyond the reach of optical microscopy, was the subject of a talk by R. D. HEIDENREICH before the New England Section of the A.I.M.E.

NATIONWIDE DIALING brings new problems to the Telephone Companies where operation with non-associate company offices is involved. At Durham, North Carolina, a 3CL switchboard is now being installed which will connect with several Automatic Electric Company dial offices. To achieve the economies of direct dialing, circuit changes in the signaling features of the non-associate equipment were suggested by H. B. NIENSTEDT in discussions with engineers of the Southern Bell Company and the local Telephone Company.

THE PRODUCTION OF HEAT in flexed rubber, it is found, depends on the cross-linking between chains of rubber molecules during the curing process. A technique for investigating this phenomenon was outlined by I. L. HOPKINS in his paper *Dynamic Shear Properties of Isobutylene Polymers as a Function of Cross-Linking*, presented at a meeting of the American Physical Society's Division of High Polymer Physics in Washington.

POLYMERS are strengthened physically, and also in their resistance to the deteriorative action of light through the inclusion of carbon black. For best results, it must be dispersed. At the American Chemical Society's meeting in Boston J. F. AMBROSE presented a paper on *Dispersion of Carbon Black in Polymers as Indicated by the Absorption and Scatttering of Light*. At the Cleveland meeting J. H. HEISS participated in sessions on the behavior of plasticizers in plastics.

THE PROBLEM of providing new telephone systems and switching devices in other countries are different from those encountered in the United States and the solutions to these problems often represent important technical contributions to the art. Last year M. J. KELLY, A. C. KELLER and H. H. SCHNECKLOTH made a technical survey of recent telephone switching developments in Europe, examining the various means employed in the different countries for furnishing metropolitan, toll, and rural service. Under the title of *European Telephone Apparatus and Switching Systems*, Mr. Keller and Mr. Schneckloth gave a brief discussion of some of their impressions of this survey before a joint meeting of the Communication and New Jersey Divisions of the New York Section of the A.I.E.E. held in Newark. W. J. RUTTER assisted in the presentation of the material.

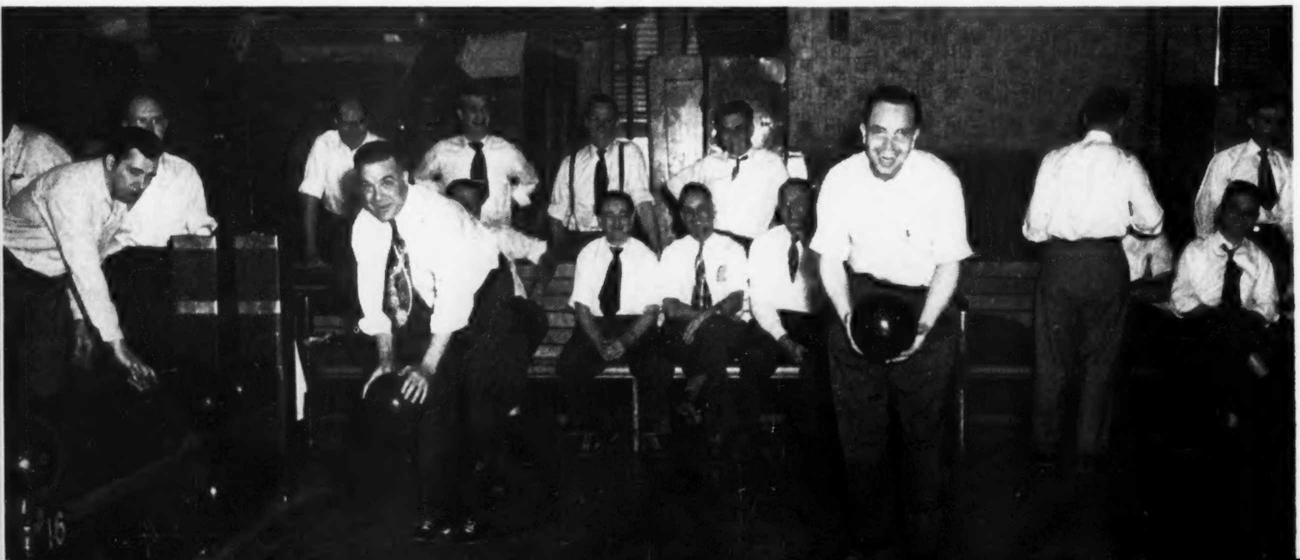
Members of "C" league gather for a picture.

Final meeting of New York Bowlers

Foul Line Judge John Dorian keeps an eagle eye on the play.

Season's winners in "A" League were (standing) W. L. Hardart, G. W. Turner; (seated) F. F. Harlin, G. Weihs, C. W. Lowe.

E. V. Paholek and H. F. Schreiber of "A" League are ready to roll.



RECENT DEATHS

W. R. Lyon
1894-1951

W. R. Lyon—*April* 22

Before joining the Laboratories in 1929, Mr. Lyon spent eight years in the teaching field, three at the University of Illinois and five at the University of Wisconsin; and five years in engineering and research in outside concerns. He had received B.S. and E.E. degrees from Worcester Polytechnic Institute and his M.S. degree from the University of Illinois.

His early years here were spent on the design of plate and filament transformers and on special transformer studies. Next he engaged in the design of measuring apparatus and then transferred to work on the development of transmission networks, particularly electric wave filters, attenuation equalizers and delay equalizers.

During World War II, Mr. Lyon spent five and a half years as a Major in the A.A.F. He was resident representative in a number of large manufacturing plants in Ohio and Indiana for two years. For the remaining time he was an instructor and later professor of electrical engineering at the Institute of Technology, Wright Air Field. In 1946 he was reverted to inactive service with the rank of Lieutenant Colonel.

Upon his return to West Street, he engaged in the development of requirements for the repair of apparatus, particularly station instruments, power line carrier equipment and coin collectors until his illness a year ago.

Mr. Lyon belonged to the Officers' Reserve Corps for thirty-two years, since World War I when he served in the Signal Corps. He was a thirty-second degree Mason, a Knight Templar and was active in the American Legion.

George Dodd—*May* 2

In 1903, and only four years after the West Street Building was completed, George Dodd came to what was then the Engineering Department of the Western Electric Company. He began as a draftsman in Apparatus Development, later becoming a supervisor of drafting, and within the past few months was made Chief Draftsman.

Mr. Dodd was born in Brooklyn, and had lived on Long Island all his life. He was educated in the Public Schools in Brooklyn, and attended Pratt and Mechanics Institutes there. For the past thirty-two years he had lived in Valley Stream, where his principal hobby was raising chrysanthemums.

He is survived by his wife Ida, a daughter, Mrs. Doris Buza, and two grandchildren.

John W. Moeller—*April* 22

John W. Moeller was employed by the Laboratories in the Plant Operations Department in 1922. He was a supervisor of the night cleaning force for a number of years and later on was transferred to a day assignment as a Uniformed Watchman. In 1944 he was made an Usher and Guard and assigned to one of our main entrances. This assignment Mr. Moeller held until his death.

George Dodd
1887-1951

J. W. Moeller
1887-1951

He is survived by his wife, Christina, and a son and daughter.

News Notes

A. H. Hearn visited the Jackson, Tennessee, plant of the American Creosote Works to observe the treatment of southern pine poles with greensalt. Greensalt, a combination of chromium copper and arsenic compounds in an aqueous solution, was investigated in laboratory and at accelerated outdoor exposure tests from 1934 to 1939 and certain rights were then acquired so as to make this preservative available for System use. Commercial installations totaling 19,000 poles were made in 1940 to 1941 and representative groups of greensalt-treated southern pine poles in Georgia, North and South Carolina, Pennsylvania and New York have shown no evidence of deterioration after eight to ten years of service.

"The Telephone Hour"

NBC, Monday Nights, 9:00 p.m.

June 4	Jascha Heifetz, *violinist*
June 11	Bidu Sayao, *soprano*
June 18	Gregor Piatigorsky, *cellist*
June 25	Nelson Eddy, *baritone*
July 2	Ken Christie's Male Chorus
July 9	Michael Rabin, *violinist*
July 16	Lucille Cummings, *contralto*
July 23	Grant Johannesen, *pianist*
July 30	Barbara Gibson, *soprano*

THE NEW ENGLAND COMPANY protection engineers held a conference which was attended by L. S. Inskip and J. B. Hays of the Laboratories and W. E. Bloecker and J. W. Danser of O & E. Mr. Inskip told the conference of current developments in protection and of results to date from trials in the New England territory of surge-resistant fuses, the surge diverter, and NC-10 protected cable terminals. Some time was spent in discussion of protection problems resulting from television distribution systems on joint-use pole lines.

A NEW WOOD PRESERVATIVE, pentachlorophenol, has been approved recently as standard for use in telephone timber products. Penta preservative, applied in a suitable petroleum solution, provides an oil-type preservative that yields long-lived poles that are free from the objectionable bleeding sometimes experienced with creosoted poles. Treatments of southern pine poles with the penta-petroleum solution were begun at the plant of the Southern Pine Lumber Company, Diboll, Texas, in April of this year. G. Q. LUMSDEN and L. R. SNOKE were in Diboll to cooperate in the initiation of the program. They participated also in the preparation of a trial lot of laminated southern pine crossarms which are to undergo extensive test plot exposure and strength tests.

TWO ADDITIONAL members of the Patent Department have been admitted to practice before the New York State Bar. These are D. H. WILSON, JR., and R. A. BUCKLES, JR. R. M. PORTER, JR., has been registered to practice before the United States Patent Office in Washington and E. W. ADAMS, JR., R. A. BUCKLES, JR., and E. B. CAVE have been admitted to practice before the United States District Court—Southern District of New York. During April, H. S. WERTZ visited the Patent Office in Washington.

G. Q. LUMSDEN, together with B. C. Close of the Western Electric Company, visited the plants in the Minneapolis area which treat western cedar and western larch poles by non-pressure methods. Poles of these species are being used to supplement the supply of southern pine poles in the sizes desired for joint use power and telephone construction.

R. H. COLLEY, A. H. HEARN, J. LEUTRITZ and G. Q. LUMSDEN attended the convention of the American Wood-Preservers' Association in Chicago, where Mr. Hearn presented a paper entitled *Relationship between Sapwood Thickness and Depth of Preservative Penetration in Pacific Coast Douglas Fir Poles.*

ISOBEL ARMSTRONG, whose picture is on the left of photograph shown below, has become engaged to Thomas Creavette, a reservist recently called back to Army duty. Miss Armstrong joined Transcription at West Street in 1948 and is now a secretary in Murray Hill Area Management assigned to two engineers in the Electronic Apparatus Development Department. Hers is a romance which began in Kearny High School and continued while she went to Berkley Secretarial School and he to Pace College. No date has been set for the wedding.

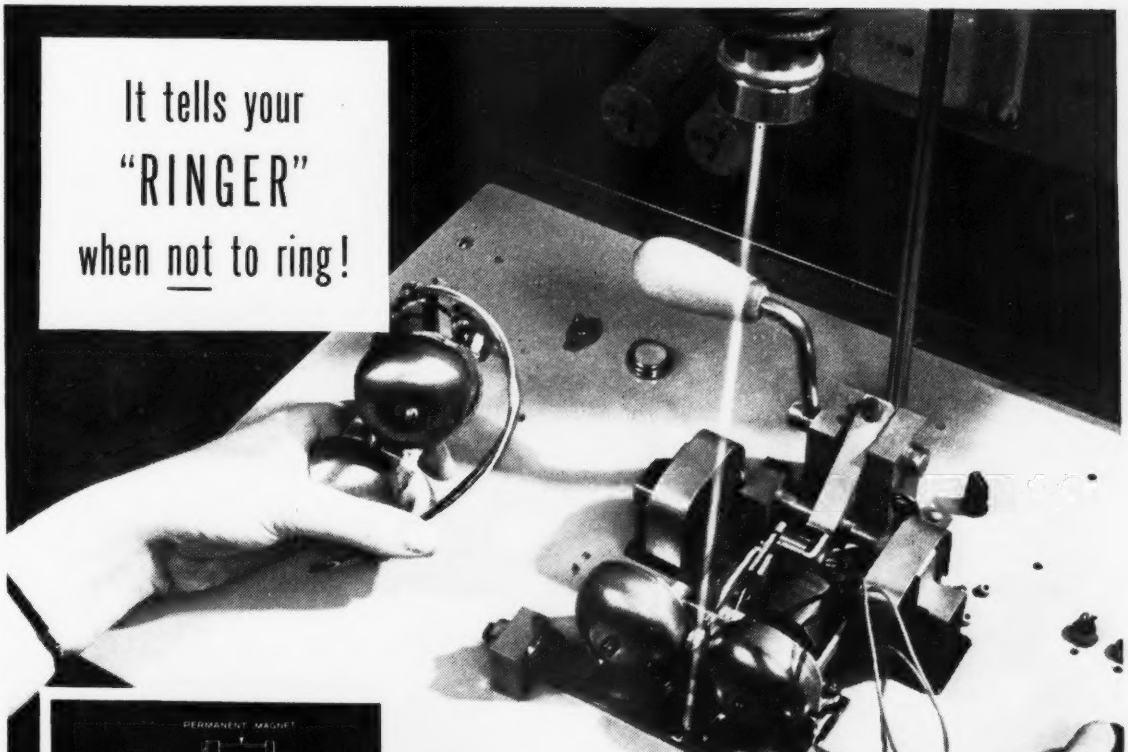
Engagements

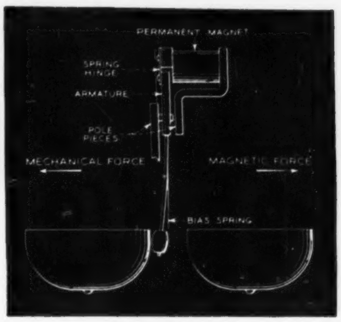
Isobel Armstrong*—Thomas Garvett
Virginia M. Mooney*—Francis A. Loehr
Caryl Schrumpf*—George Geisenhainer
Janice Vrabel*—Frederick Garman

Weddings

Marie Adler*—Robert Grillo
Patricia T. Fehr—John Hugh McGuigan*
Cynthia Glasson*—James Preston*
Justina Howansky*—Robert Masters
Ethel Lane*—Frank R. Monforte*
June Marky*—Stanley A. Rohrbacher
Helen Meiser*—Roy A. Metzler*
Rosemarie Sabia—William P. Cucco*
Elizabeth M. Walker*—Joseph A. Kahl
Nancy White*—Lawrence G. Kersta*

*Members of the Laboratories. Notices of engagements, weddings and births should be given to Mrs. Helen McLoughlin, Sec. 11A, Ext. 296.





The Bell System's new automatic method of adjusting telephone ringers uses a beam of light passing between the gongs to a photoelectric cell. When test currents are applied to the ringer the machine decides whether to change the spring tension or the magnetic pull. After each change it tests again until the ringer is in perfect adjustment—and the whole procedure takes only 30 seconds.

To you, it's your familiar telephone bell. To telephone engineers, it's a "ringer." And it has two jobs to do.

It must ring, of course, when someone calls you. And it must overlook the numerous electrical impulses which do not concern it, such as those sent out by your dial.

Ability to respond to some impulses, to ignore others, requires exact adjustment between the pull of a magnet and the tension of a spring. If they are out of balance your telephone might tinkle when it oughtn't, or keep silent when it should ring.

In the past, adjustment was made by hand, little by little until the proper setting was reached. It took time. But now Bell Laboratories engineers have developed a machine which adjusts new ringers perfectly, before they leave the Western Electric Company plants where they are made. And the operation takes just 30 seconds.

This is another example of how the Laboratories work constantly to improve every phase of telephony – keeping the costs low while the quality of service grows higher and higher.

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WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE ONE OF TODAY'S GREATEST VALUES

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